POWER

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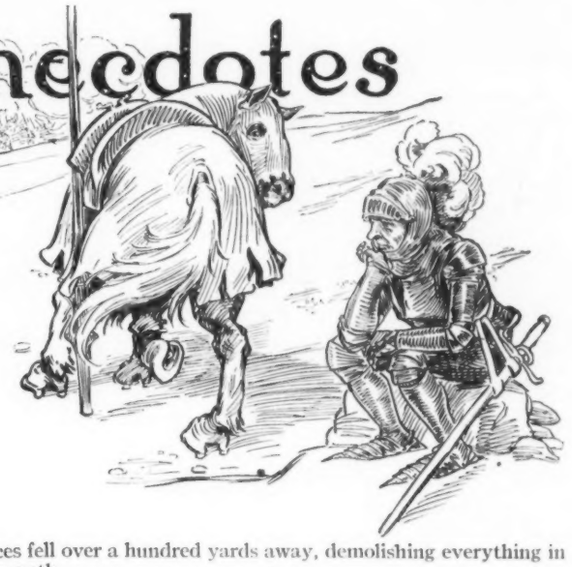
Purposeful Anecdotes



Better Be Sure Than Sorry

For the want of a nail, a shoe was lost,
For the want of a shoe, a horse was lost,
For the want of a horse, a rider was lost,
For the want of a rider, a battle was lost,
For the want of a battle, a kingdom was lost.
And all for the want of a horseshoe nail.

IT IS NOT HARD to get authority to purchase a safety device after the need of it has been driven home by a sacrifice of property and perhaps life. It is another matter to convince the management of such a need where an accident never occurred.

The owner of a certain factory installed a complete system of accident-prevention appliances—at least it was intended to be complete. Every gear, pulley, belt or stairway was protected with the most elaborate devices in the market, but—

When the engineer complained that his part of the plant was being overlooked, and that if anything happened to his engine, all the machinery, protected or otherwise, would be dead, maybe for months—when he suggested this, the owner told him that he had ample protection already.

"What could happen, John?" he asked: "how could the engine run away or overspeed when it has the best governor ever invented, and you or your assistant, Charlie, are always in the engine room?"

It's hard work for some men to beat the boss in an argument, and many a good suggestion for betterment, or safety, has been lost because of lack of self-confidence—of being too timid to "talk up" to the management.

So, the subject was dropped, after the owner of the factory had, as he thought, beaten some reason into the engineer's thick head.

Then came the day when the stage was set for a first-class accident. All the conditions were perfect. The machinery had been working like clockwork; not a hitch anywhere, and the owner recalled, with a smile, the engineer's preposterous attempt to have him safeguard the engine—the engine that cost so much and worked so beautifully. John was on the third floor making some small repairs, directly over the engine room. Charlie, his assistant, sat in the old cane chair, sleepily watching the twinkling spheres of the governor as they swung after each other.

Suddenly, Charlie sat up with a jerk. The shining balls had ceased to swing and lay quiet beside the stem. But the engine was running—yes, but at what a speed. Frightened, Charlie was fascinated—lost his head, and rushed to the telephone to summon help. Before he could get the operator, a new noise caused him to drop the receiver and run for the open door. The big wheel was turning like lightning and the beautiful new engine was tugging as if it would rise from the concrete. Nobody but a madman would go near the throttle now, and Charlie was not quite a lunatic yet. Bursting into the office, he yelled "Something is wrong. Where's John?" but before the startled owner could reply, a horrible grinding noise was heard in the direction of the engine room, and the walls of the building vibrated to a shock that almost shook the men off their feet.

The flywheel had let go. Tearing their way upward and outward, through floors, heavy beams, shafting and machinery, fragments of the wheel were discharged as if propelled by guncotton. Pieces fell over a hundred yards away, demolishing everything in their path.

With pale faces and trembling chins, the two men moved cautiously to the place where the engine room used to be. Nothing could be seen because of the dense cloud of steam that roared through the broken main, but when the subsiding pressure allowed the vapor to escape through the torn roof, the owner and assistant engineer saw—and understood.

"Go and find John," said the owner. A few minutes later Charlie returned. His soiled handkerchief was pressed to his eyes. The men looked at each other.

"Did you find him?" asked the owner.

"Yes," said Charlie, in a choking voice—"Poor Jack."

Sentiment and business are not good bedfellows, and it was not long before the owner began reconstruction. The advice of the dead engineer was recalled in bitterness of spirit. The financial loss was heavy, the plant being closed for nearly three months for repairs and installing a new engine and transmission, including a fine new flywheel, bigger than the old one.

Visitors to the new power plant saw something not on the old engine which excited considerable curiosity. This was a modern, automatic engine stop, provided with connections which enabled the engine to be stopped from convenient stations located anywhere in the factory. It was arranged also to stop the engine automatically if there was any advance of speed over a prescribed maximum. Furthermore, it could be operated electrically, and one method of operation did not interfere in the least with the others.

There will never be a flywheel explosion in that plant again—at least so long as the engine stop stays on the main where the ill-fated John often wished to see it. The new man stops his engine twice daily by pressing a button, and takes pleasure in telling visitors how, when a breaking shaft once threw all the load off and the engine began to race, the engine stop lever clicked quietly once, and the steam was shut off instantly.

No engineer can tell when, or why, or how much his engine will race under certain emergencies. Governors of the usual type are probably no more reliable than the engine itself. They are auxiliary safeguards, subject to their own peculiar derangements. Belts will slip and gears will clog unexpectedly, and once an engine begins to race there is only one thing to do—shut off the steam. If the engineer has nerve and happens to be there, he will close the throttle, unless the flywheel lets go first. A reliable engine stop attends to that matter whether the engineer is asleep in his bed or talking politics to the fireman in the boiler room.

(By J. St. C. McQuilkin)

Power Plant of American Engineering Company

SYNOPSIS—A small power plant embracing interesting features of design. The arrangement and equipment are such that the plant is easily and economically operated and provision is made for obtaining daily records of performance.

The ground plot on which the power plant of the American Engineering Co., Philadelphia, Penn., is built, is bounded on three sides by city streets. This placed a restriction which was further complicated by the intersecting streets not being at right angles to one another. The requirements were sufficient engine and boiler capacity, together with all auxiliaries and coal- and ash-storage capacity, and so arranging all the equipment that operation would be easy, convenient and economical.

Since one of the three streets contained a railroad siding, it was important to have the coal-bunker and coal-handling system convenient to the siding and also to provide space for a private siding for unloading coal.

The generating capacity of the plant is 540 kw., or 737 hp., made up of one 13 and 22 by 18-in. tandem-compound engine directly connected to a 150-kw., 250-volt, direct-current generator; two 13 and 23 by 16-in. tandem-compound engines, each directly connected to a 165-kw., 240-volt, direct-current generator; and one 12x12-in. single engine directly connected to a 60-kw., 110-volt, direct-current generator. Figs. 1 and 2 show the engine room.

In addition to the foregoing, the engine room contains the forced-draft equipment for the stokers, consisting of one steel-plate blower directly connected to either of two 5x5-in. vertical engines. All of the engines run non-condensing, the exhaust steam being used for heating the boiler feed water and also for heating the shops and offices.

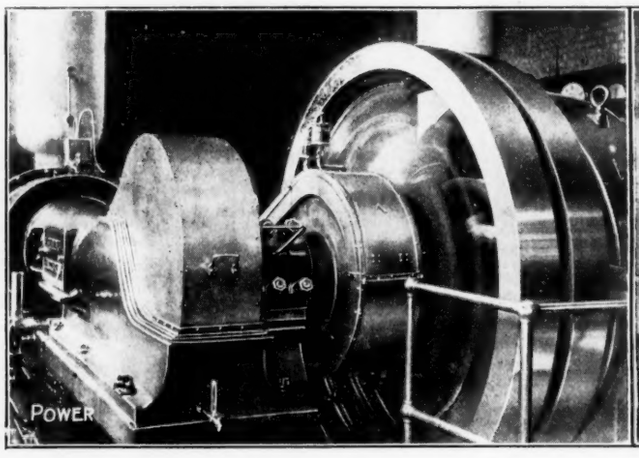


FIG. 1. ONE OF THE MAIN ENGINES AND GENERATORS IN THE POWER PLANT

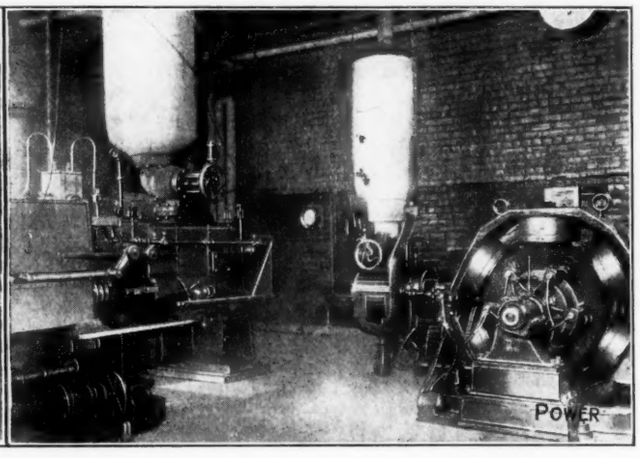


FIG. 2. THE SMALL UNIT AND STEAM END OF A COMPOUND ENGINE

The boiler room has three cross-drum water-tube boilers, each having 1500 sq.ft. of heating surface and is equipped with a gravity under-feed stoker. There are also two 6 and 4 by 6-in. outside-packed duplex feed pumps, two feed-water heaters and a V-notch recording water meter (Fig. 4).

The plan of the power house (Fig. 8) shows the location of the equipment and railroad switch, and Fig. 3 shows a sectional elevation through the engine room, boiler room and coal bunkers. The compactness of this arrangement is such that there is practically no waste space, the equipment is not crowded and there is plenty of room to make the repairs and adjustments.

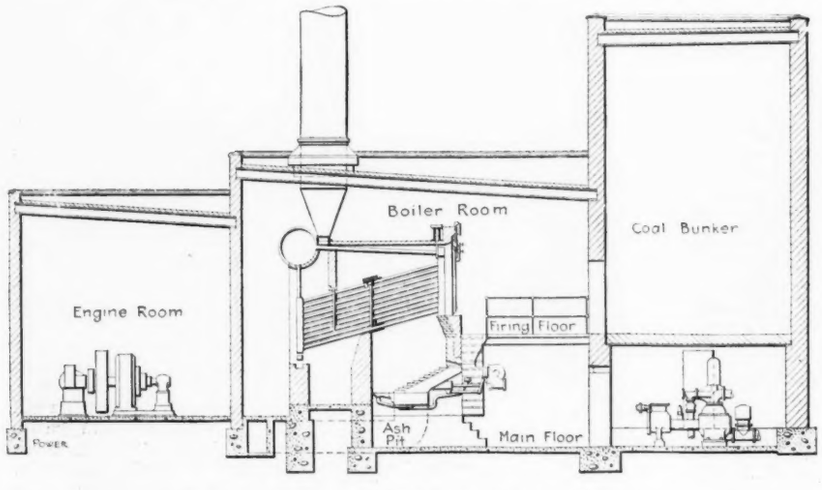


FIG. 3. SECTION ON LINE *AA* OF FIG. 4

The combined layout of boilers, stokers, ashpit, coal bunkers, ash hoist and firing floor is interesting. The lower boiler room is practically on the street level, with the boilers and stokers so set that the lower floor is also the level at which ashes are removed from the pits.

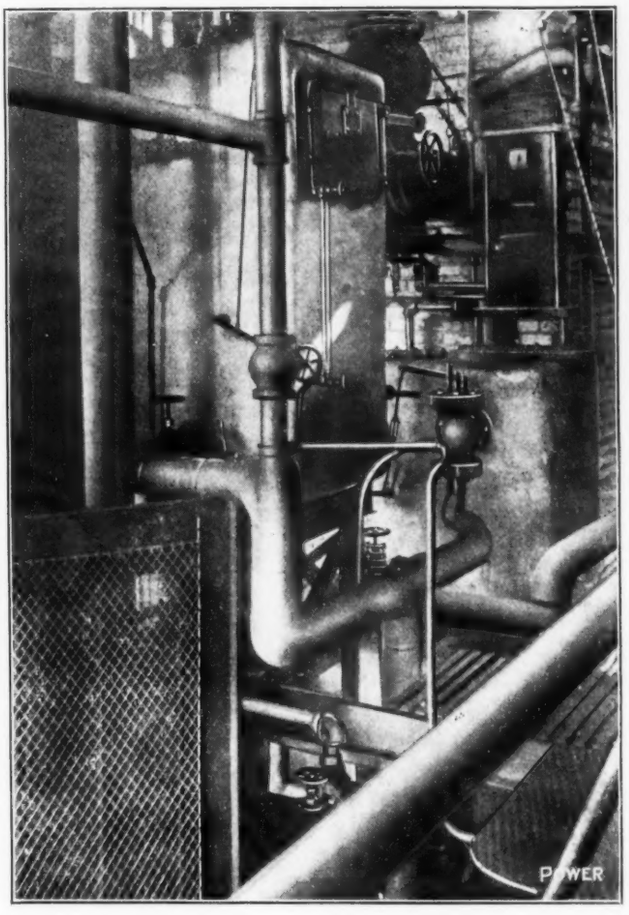


FIG. 4. FEED-WATER HEATERS AND V-NOTCH RECORDER

The upper or firing level is flush with the top of the stoker coal hoppers and is also level with the bottom of the coal bunker. The firing floor extends from the boiler fronts to the coal bunker. In the other direction, the floor is only the width of the boilers, a narrow passageway connecting the firing floor of the battery of two boilers to the firing floor of the boiler set singly.

Platform scales are built into the firing floor in front of the coal bunkers. The coal is wheeled from the bunker to the stoker hoppers, each wheelbarrow of coal being weighed and then dumped into the stoker hoppers.

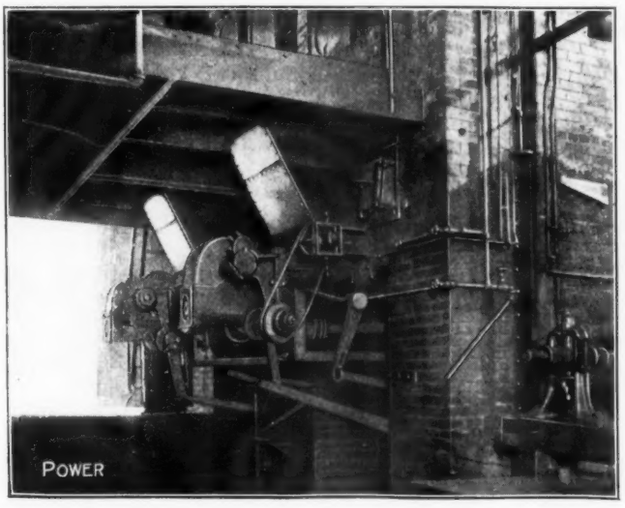


FIG. 5. STOKERS BELOW CHARGING PLATFORM

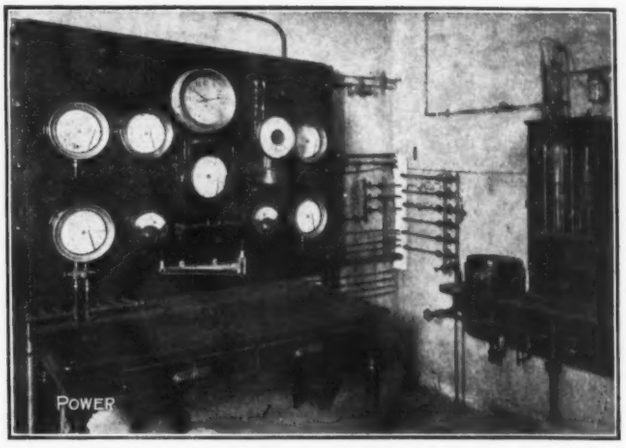


FIG. 6. RECORDING INSTRUMENTS IN ENGINEER'S OFFICE

Figs. 5 and 7 are views of the boiler room from above and below the firing floor. Slack coal is usually used and is dumped from the car through a cast-iron grating into a bucket conveyor which deposits it in the bunker. Any lumps which will not pass through the grating are broken through, making a crusher unnecessary.

The ash is wheeled to a conveyor on the same level as the ashpits and then elevated to a bunker so arranged that a truck can back under it and the ash can be discharged for final removal.

A chief engineer, an oiler and a stoker operator con-

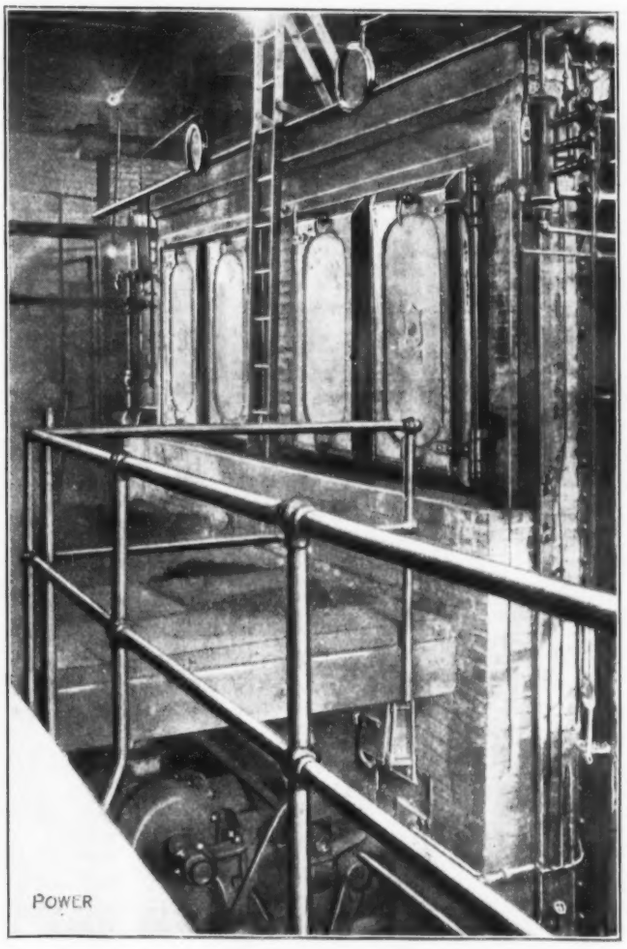


FIG. 7. CHARGING PLATFORM, STOKERS BELOW

stitute the operating force. The stoker operator tends the water, weighs the coal and removes the ashes.

The boiler gage glasses are in plain view from either the firing floor or ashpit level, and the feed valves are controlled from either floor, thereby making it unnecessary for the operator to make trips from one to the other level to regulate the water. The rate of coal feeding and the air pressure required for burning it are controlled automatically in accordance with the demands for steam, therefore the fireman is not required to continually watch the steam gage nor regulate the drafts, etc.

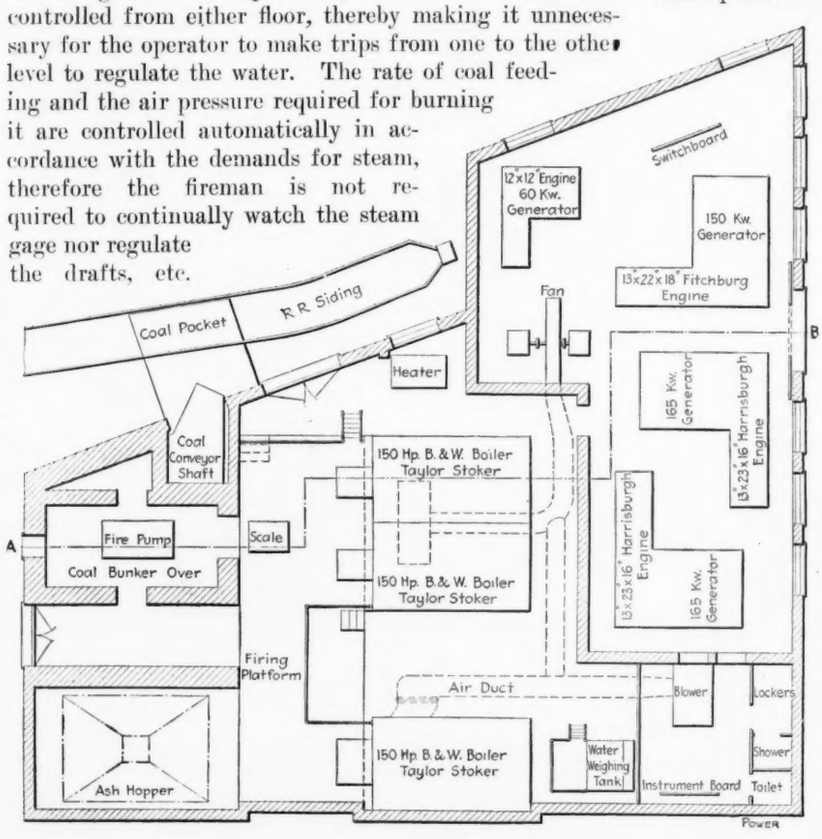


FIG. 8. PLAN OF POWER PLANT

The stoker hoppers are of sufficient capacity to give the operator ample time to remove the ashes without giving them any further attention. The plant is so compact and conveniently operated that two men could easily run it. However, since the cost of fuel is the main item of expense in any power house, it was deemed advisable to use an extra man, thereby giving the chief engineer time in the boiler room to see that the maximum fuel economy is maintained.

No. 3 boiler is equipped with an independent feed pump, weighing tanks, fan equipment and a set of recording instruments for recording simultaneously all varying conditions throughout the boiler and furnace. Thus, experimental and test work can be carried on without interfering with the normal operation of the plant. These instruments are connected to be used on any of the three boilers, thus affording the chief engineer accurate information on conditions and assisting in maintaining high economy.

The instruments, mounted on a panel (Fig. 6), are a steam-pressure gage, feed-water thermometer, air-pressure gage, differential draft gage, and flue-temperature thermometers and all the recording instruments. There are also a steam-flow meter and a recording CO_2 meter. They cover all conditions subject to variation and show graphically the relations of one to the other. All instruments are checked periodically.

In addition to the electrical load, which includes five electric traveling cranes and a fan for the foundry cupola, steam is used to drive an air compressor in the shops, for the steam hammers in the forge shop and for test purposes on the engine-test floor. From the character of the load it can readily be seen that the load has wide limits.

The steam pressure is automatically held practically constant at 160 lb. The stokers are driven from the fan shaft, and a damper regulator, connected into the main steam header, controls the speed of the forced-draft fan. The regulator operates on about two pounds' variation in steam pressure. In varying the speed of the fan, the air pressure and the rate of coal feed are controlled simultaneously. Once the correct ratio of air supply to the coal feed is obtained, no further hand adjustments are necessary.

PRINCIPAL EQUIPMENT OF AMERICAN ENGINEERING CO.'S POWER PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
1	Engine	Simple	12x12-in	Main unit	245 r.p.m., 160 lb. steam	Harrisburg Foundry & Mch. Co.
1	Engine	Compound	13x22x18-in	Main unit	225 r.p.m., 160 lb. steam	Fitchburgh Steam Engine Co.
2	Engines	Compound	13x23x16-in	Main unit	245 r.p.m., 160 lb. steam	Harrisburg Foundry & Mch. Co.
1	Generator	Direct current	60 kw	Main unit	245 r.p.m., 110 volts	Electro Dynamo Co.
1	Generator	Direct current	150 kw	Main unit	225 r.p.m., 240 volts	General Electric Co.
2	Generators	Direct current	165 kw	Main unit	245 r.p.m., 240 volts	Triumph Electric Co.
2	Engines	Vertical	5x5-in	Fan drive	Variable speed to 446 r.p.m., 160 lb. steam	B. F. Sturtevant Co.
1	Fan			Forced draft	Variable speed to 446 r.p.m.	B. F. Sturtevant Co.
3	Boilers	Water tube	1500sq.ft heating surface, each	Main generators, one experimental	160 lb. steam, forced draft	Babcock & Wilcox Co.
3	Stokers	Taylor		Boiler furnace	Chain driven, automatic regulated	American Engineering Co.
1	Meter-heater	Cochrane V-notch		Feed water	Continuous	Harrison Safety Boiler Works
1	Heater	Vacuum		Feed water	Exhaust steam	Warren Webster Co.
2	Pumps	Duplex	6x4x6	Boiler feeders	160 lb. steam, one reserve	Henry R. Worthington
1	Recorder	CO_2		Flue gas	Recording continuously	John A. Hays
1	Recorder	Draft		Stack draft	Recording continuously	John A. Hays
1	Meter	Steam flow		Steam supply	Recording	General Electric Co.

New Composition Valve Disk

A new composition disk for steam service has been perfected by Jenkins Bros., 80 White St., New York City, and will hereafter be used in all of the company's standard pattern globe, angle, cross and radiator valves.

The disk will be known as No. 119. The composition is hard, but becomes tough and flexible in service when under steam pressure. It shows freedom from cracking and flaking and is durable with steam pressures up to 150 lb.

The Volume of Air Handled by a fan is proportional to the speed, and the power required to drive the fan varies as the cube of the speed. That is, to double the amount of air will require eight times the horsepower.

Opelousas' Municipal Lighting Plant

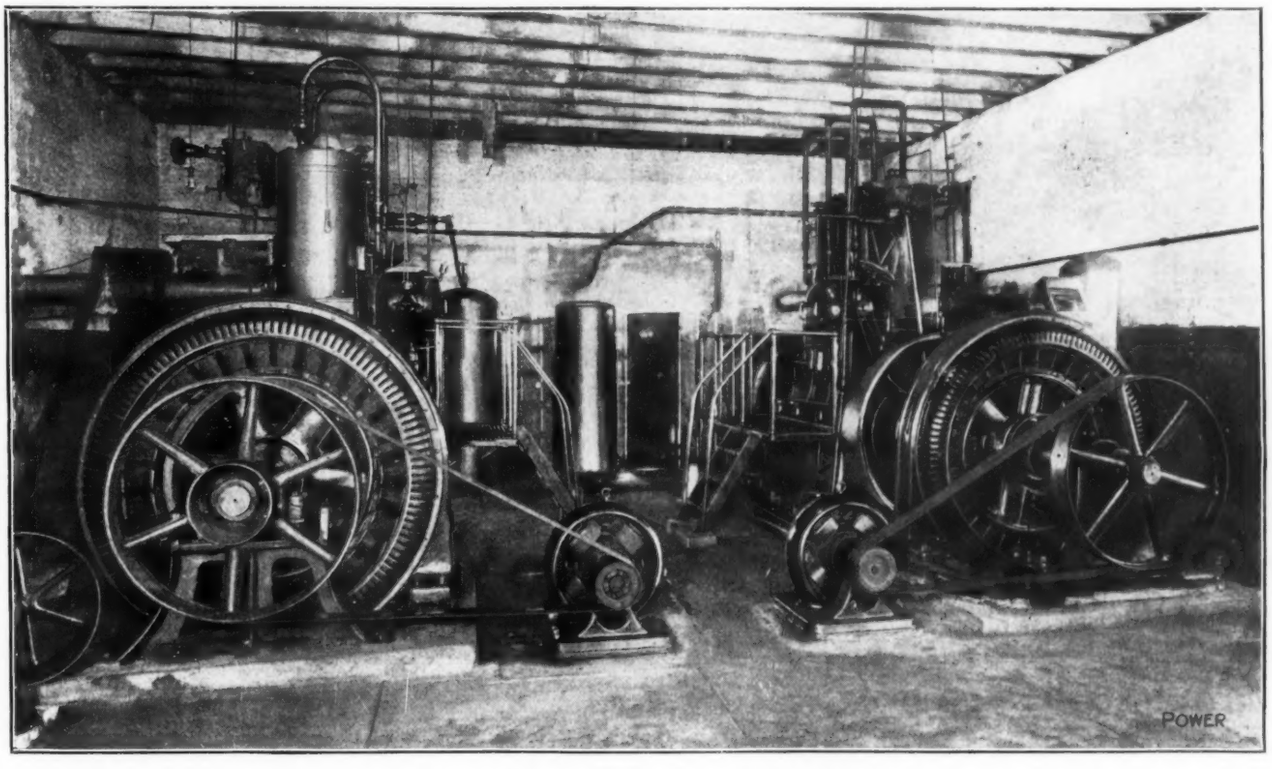
SYNOPSIS—The following is taken from a communication from A. C. Jones, superintendent of the municipal light and water plant of Opelousas, La., and recites some of the struggles of a small plant in a town of about 5000 inhabitants. Due to the comparatively high price of coal, and the local conditions an oil-engine plant appears to have shown considerable saving over the former steam plant.

The electric-light and water-works plant was installed by this city in 1897, and consisted of one 110-hp. center-crank steam engine, two return-tubular boilers, one 50-kw. alternator, and one 40-light arc machine. There were also two water-works pumps each of 500-gal. capacity. This equipment was kept in service for a number of years and another alternator and engine were added, after which the arc machine was discarded and alternating inclosed arc lamps replaced the open arcs. This equipment gave good service and the city was able to operate it satisfactorily until about 1909 when fuel started to increase in price to a point that meant serious loss unless something was done to decrease the amount consumed. As soon as the plant started to lose more than the city could afford, the management was unable to get enough money to keep the machinery in repair. Moreover, due to local conditions, the load fell off considerably.

Finally, after spending about $1000 in repairs, a new steam plant was recommended and purchased, consisting of a tandem-compound, four-valve engine direct-connected to a 150-kw. alternator and a B. & W. boiler. This was a first-class outfit, but the results were not much better than with the old plant.

By the early part of 1911 the city finances had reached a desperate state, and it seemed that the plant would have to be shut down. The receipts from electric and water service were insufficient to pay the fuel bills, so that it had become a regular custom to borrow money from the banks to pay for fuel. The employees had to go to the banks and borrow their salaries on their own notes and at the beginning of the next year the city council would pay these notes, with interest, out of the license funds.

A new city council took charge of the city's affairs in 1912, and realizing that radical changes had to be made in the electric-light and water-works plant, arranged to increase the tax rate three mills for two years and borrowed $6000 on it. With this money there was purchased an oil-engine plant consisting of a 100-hp. Mietz & Weiss engine, direct-connected to a Fort Wayne alternator, a generator panel, a feeder panel, one 500-gal. Lawrence pump direct-connected to a 35-hp. three-phase motor, and a 12x10-in. Ingersoll-Rand air compressor with short belt drive from a 35-hp. motor. This installation cost a little over $11,000. Since the management had only $6000, it was necessary to arrange to pay out of the money collected from the electric and water service; this was fixed at $200 per month with interest.



Engine Room of the Opelousas Plant

This first unit was put into regular service in December, 1912. As it was not large enough to carry the peak load, it was necessary to run the steam plant for about three hours each night, but in spite of this the December report showed a profit of $427.82, and each month since has shown a profit.

Some time after this a second oil-engine set of 100-kv.-a. capacity was purchased, together with a 300-gal. motor-driven pump. This installation was completed Jan. 1, 1914. It cost installed $10,842, leaving a debt of $5842 on this part of the plant, which was to be paid from revenues at the rate of $250 per month with 5 per cent. interest. The plant is now paying each month $450 with interest, in addition to paying all labor and operating expenses out of collections for electric and water service. The city pays the plant $321 per month for street lighting and water service.

To improve the service the present superintendent put up 25 lightning arresters and grounded the neutral on the secondaries. This practically stopped all trouble due to lightning, which had previously been a great source of trouble. In fact, it had been customary after a heavy flash of lightning for the operator to go to the telephone and ascertain what damage had been done, so as to make repairs before dark, if the storm happened during the day time.

The water-works system is supplied with water by two motor-driven centrifugal pumps. The water in the well is 42 ft. from the surface of the ground, so that it is necessary to use an air lift to pump to the reservoir. This air is supplied by the motor-driven air compressor.

The electric service is all metered and the rates are as follows:

250 kw.-hr. or less per month, 10 cents.
300 kw.-hr. or less per month, 9 cents.
350 kw.-hr. or less per month, 8 cents.
All over 350 kw.-hr. per month, 7 cents

There is a minimum charge of 50 cents per month on 1 to 10 lights, 75 cents on 10 to 20 lights and $1 on all over 20 lights. There is practically no motor load connected except in summer for driving fans. The December load is a little over 100 kw. and the mid-summer peak load about 60 kw.

It might be mentioned that the price of oil in this locality is from $3.65 to $4 per ton and oil $1.10 per barrel, although it has reached as high as $1.55.

New Kincaid Stoker

"Fire light and often" is the injunction frequently given the fireman by the engineer who has made a study of the factors conducive to high boiler efficiency. With hand firing, the impediments to the complete success of this plan are: First, it entails more work on the part of the fireman so that he is inclined to lengthen out the intervals or, if he follows instructions, it reduces his capacity. Second, the necessarily frequent opening of the fire-door admits large quantities of excess air, reducing efficiency and tending to offset the advantages otherwise obtainable.

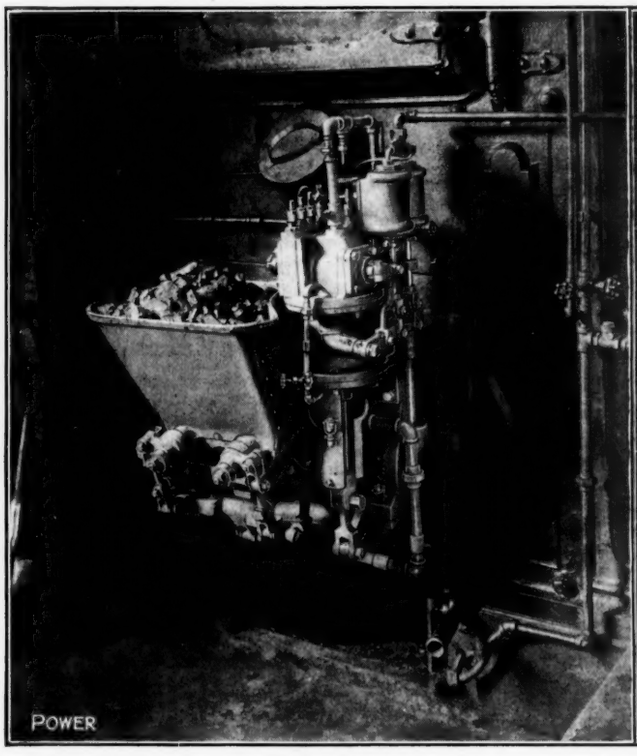


FIG. 1. KINCAID STOKER HINGED TO BOILER FRONT

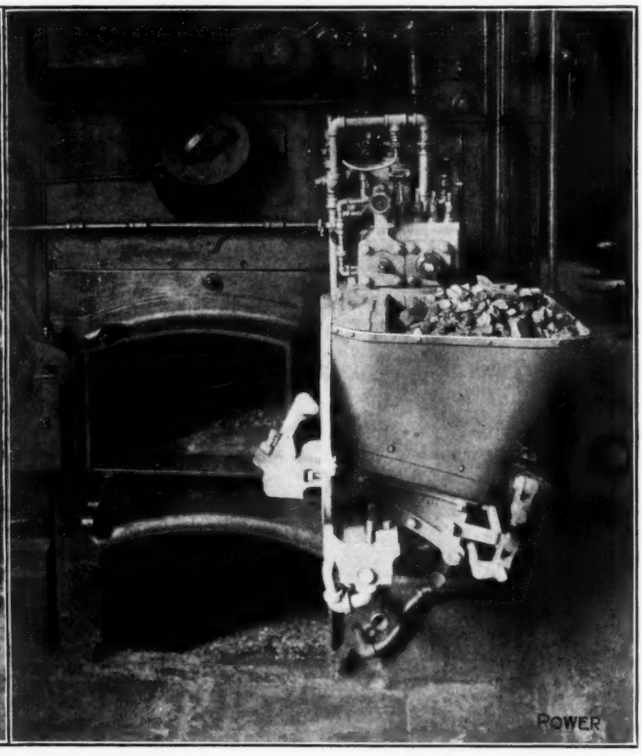


FIG. 2. ENTIRE STOKING MECHANISM SWUNG FREE FROM FIRE-DOOR

The Kincaid stoker, illustrated herewith, is designed to secure the full advantages of frequent firing of small charges while excluding the impediments just mentioned. When small charges are fed rapidly and regularly to the fire, good combustion is secured with practically any grade of fuel because the unbalanced fuel-and-air supply is eliminated. With hand-firing when fresh fuel is thrown on the grate, the air supply to the freshly covered portion of the fire is insufficient. Another difficulty is that with coal of a clinkering nature, large charges result in large clinkers. The clinkers are not only difficult to handle, but they are objectionable for the more important reason that they interfere with the uniform distribution of the air supply, which is indispensable in securing good combustion.

The stoker under discussion catapults anywhere from 3 oz. to 2 lb. of coal per charge at the rate of from 10 to 75 charges per minute, depending upon the requirements of the boiler. The coal is distributed evenly over the area of the fuel bed, as will be evident from the following description.

Fig. 1 shows the stoker in position. The apparatus is hinged on a frame bolted to the boiler front and no change in setting or boiler front is required other than the removal of the fire-door and the attachment of a fire-door frame. Being hung on hinges, the stoker may be swung clear, as in Fig. 2, for cleaning, trimming or hand-firing, should occasion arise.

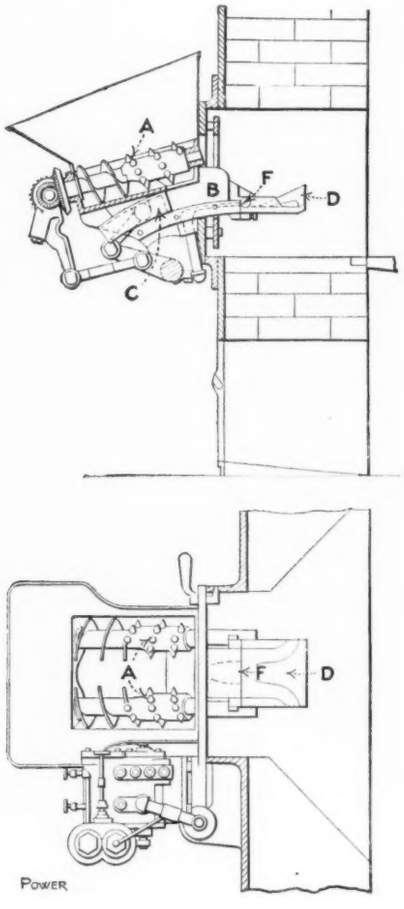


FIG. 3. SIDE AND TOP VIEWS OF STOKER, SHOWING CRUSHING ROLLS AND SPREADING PLATE

Referring to Fig. 3, the coal is fed toward the furnace in regulated quantities by means of the worms and crusher rolls *A*. The crusher rolls make it possible to use coal of any size from slack to 8-in. lumps or even mixed sizes such as mine-run, etc.

The coal drops into a rectangular space *B* in front of the ram *C*. The ram is actuated by a steam piston shown at the right of the hopper in Fig. 1. The worms *A*, Fig. 3, work intermittently so that when the ram is delivering a blow against the coal in space *B*, no coal is being fed forward. When the ram is withdrawn for the next blow, the same motion actuates the worms through a predetermined portion of a revolution. Thus, the same quantity of coal is fed to the ram for each successive blow. This quantity may be varied by changing the "throw" of the ratchet arm which turns the worms.

Steam is admitted to one side of the piston which drives the ram by means of a rapidly acting valve in much the same manner that air is admitted behind the piston of a pneumatic hammer. The acceleration of the ram is rapid, but at the end of the stroke, the piston is cushioned by a small quantity of steam trapped in the end of the cylinder so that there is practically no mechanical shock when bringing the ram to rest.

By means of a simple, adjustable throttling mechanism the pressure of the steam admitted behind the piston may be successively varied to secure strokes or blows of four different intensities. Hence, the first or weakest stroke delivers a charge of coal over the first or front quarter of the fuel bed; the second stroke delivers to the second quarter, and so on. The spreading of the coal is accomplished by means of the nozzle plate *D*.

The exhaust from the ram cylinder is led to a $\frac{3}{8}$x3-in. rectangular nozzle at *F*. The events are so timed that a blast of exhaust steam emerges from *F* at the instant that a flying charge of coal reaches the nozzle plate. Consequently, the steam catches, partly carries and assists in spreading the coal over the various portions of the fuel bed. Naturally, the intensity of the blasts of exhaust steam varies directly with the intensity of the stroke of the ram. Even spreading of the coal depends upon the contour of the nozzle plate *D*, which is varied to suit furnaces of different shapes and proportions.

The fluctuations in the demand on the boiler are accommodated by varying the number of charges of coal thrown per minute and by varying the size of the individual charge. The former method is usually employed, while the latter is resorted to only in cases of extreme variation. This change in speed is accomplished by means of a small steam pilot piston, the speed of which is controlled by a water dashpot to which it is yoked. The resistance of the water piston is varied by constructing or enlarging the passage through which the water is forced to flow from one end of the cylinder to the other. This arrangement permits of both hand and automatic control.

The stoker is manufactured by the Kincaid Stoker Co., 507 East Pearl St., Cincinnati, Ohio.

Tagliabue CO_2 Thermoscope

The Tagliabue CO_2 Thermoscope is a new device in this country, but it was fully described on p. 428 of the Sept. 23, 1913, issue of POWER, as manufactured by an English company. Now it is being manufactured in this country by the C. J. Tagliabue Manufacturing Co. 18-88 Thirty-third St., Brooklyn, N. Y.

This device is used to indicate the percentage of CO_2 in flue gases. It reads directly on a plain scale and requires no correction for atmospheric conditions.

First Class Engineer almost burned his eyes out measuring between two switchboard blocks with a brass-bound rule.

Thoughtlessness—A man working on a live 2300-volt panel reached as far as he could to lay a blow torch upon the metal window casing of a reinforced-concrete building. His reach was a little short and that saved him, but the foreman saw him and gave him a week to think it over.

Draft Readings on a Stirling Boiler

By S. H. Viall*

SYNOPSIS—Deals with the importance of taking draft readings at different points in a setting and how they may be analyzed and compared with those from a standard setting.

On boilers having natural draft, the reports of many tests give the draft intensity at the stack side of the damper or at some point in the breeching, but they do not mention the available draft over the fire. With open ash-pit hand-fired boilers it is the difference in pressure between the boiler room and the furnace that tends to cause air to pass through the fuel and governs the rate of combustion and in turn the capacity of the boiler. Other information is necessary besides the draft at some point in the breeching. The arrangement of the baffling, the accumulation of flue dust or other factors that affect the size and shape of gas passages—all have a bearing on the coal-burning capacity of the unit.

In the article, "Draft Loss through Boilers" (Power, June 2), valuable information on the average loss of draft intensity through different types of boiler is given. It is common to find power houses operating at capacities lower than would be available if intelligent attention were given to the draft conditions. In some plants more boilers are used than should be required, while in other plants trouble is experienced in maintaining the steam pressure.

The writer will briefly describe the work done at a certain plant and show how the information given in the article referred to can be used to advantage in analyzing conditions in other plants.

Fig. 1 illustrates the points at which draft readings have been taken in Stirling boilers operating on natural draft and giving satisfactory service as to capacity and efficiency. The average of these readings reduced to a percentage of the draft at the stack side of the damper, considered as 100 per cent., is shown by curve No. 1 of Fig. 3, and the data are given in Table 1. This curve corresponds closely to the data given for the standard Stirling boiler, Fig. 18, on page 769 of the June 2 issue.

TABLE 1 — PERCENTAGE OF DRAFT AVAILABLE THROUGH STIRLING BOILER; 100 PER CENT. AT G

No. of Curve	A	B	C	D	E	F	G
1	4	33	41	49	68	93	100
2	3	13	23	35	48	97	100
3	3	18	52	61	77	80	100
4	4	25	39	48	60	69	100
5	4	24	36	43	57	66	100

Fig. 2 illustrates the boiler setting at a plant which was having difficulty in generating sufficient steam to carry the load. It was known that the boiler was not overloaded and that it was clean both inside and out. The truth was that the furnace could not burn enough coal. Draft readings were taken at the points indicated. The connection between the boiler and breeching was as shown. An opening was drilled through the steel breeching connection between the damper and the boiler at the point *G*. Although this point is on the boiler side of the damper, while in Fig. 1 the corresponding point is on the stack side, the two locations are comparable on account of the loss in Fig. 2, due to a turn in the gas pass between *F* and *G* and also to the loss in taking the gases downward in the breeching. The first sets of draft readings taken on the setting, Fig. 2, are given by curve No. 2 and in Table 1.

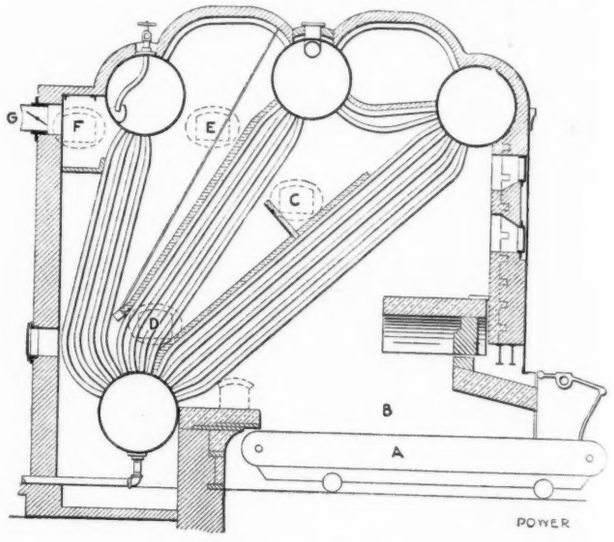


Fig. 1.

The loss in draft from one point of reading to another is shown more clearly by the curves than in the tables. By referring to Fig. 3, it will be observed that there is a considerable drop between points *F* and *E*, curve No. 2, as compared with the drop between corresponding points on curve No. 1; the latter is the curve for average conditions. Investigation as to the cause of this drop showed that the passage for the gases between the rear drum and the top of the baffle on the rear tubes was only 10 in. high. Tile was removed from the rear bank of tubes down to a level with the shelf at the breeching connection. This increased the opening from the drum to the shelf to 9 ft. Ordinarily this opening would be considered excessive, but as the breeching connection was a downtake of odd design to a tunnel below the floor, and as, after the change, the average temperature of the gases at *G* was only 10 deg. higher, and this with a higher rate of combustion, it is apparent that the action taken was warranted.

A second set of draft readings was taken and appears in curve No. 3. It will be noticed that the available draft over the fire is greater than in curve No. 2. The loss from *G* to *F* is greater, but the loss from *F* to *E* is small. The curve is approximately normal to point *C*, but the drop between *C* and *B* is excessive. It will be observed that the percentage of draft available at *C*, curve No. 3, is more than the percentage available for the corresponding point on the normal curve, No. 1, while at point *B*, on curve No. 3, there is less draft available than for the corresponding point on curve No. 1. This shows clearly that the restriction between these two points is greater than the average.

Further investigation showed that the baffle at the rear of the front bank of tubes was close to the front drum,

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also that the Stirling arch extended to within 4 in. of the front tubes. The gas passage between the drum and front baffle was enlarged and about 9 in. of brick cut from the arch.

A third set of draft readings was then taken, and the results are shown in curve No. 4. It is shown that the available draft over the fire is higher than in curve No. 3, also that the drop from *G* to *F* has increased. Likewise, the drop throughout the rest of the boiler has shown a slight increase except at the points on the fire side of the enlarged openings. The increase in draft loss between *G* and *F* of curves Nos. 3 and 4, as compared with curve No. 2, is due to the presence of a greater volume of gas per unit of time on account of increased coal consumption per square foot of grate. More fuel was burned by the additional air supplied to the furnace.

The drop in draft intensity from *C* to *B* on curve No. 3 is greater than on curve No. 2. The openings between these two points were of sufficient area when handling the gases produced at the lower rate of combustion. When this was increased the volume of gas was greater and the areas between *C* and *B* proved to be too small. After the conditions shown by curve No. 4 were established, there was no further change made in the baffling, because the available draft was sufficient to produce the capacity necessary to carry the load. In other words, satisfactory commercial conditions had been provided and in the estimation of the management any benefit to be realized by further work would not justify the extra labor.

Curve No. 5 is plotted from a set of draft readings taken at a later date than those of curve No. 4, but with boiler and furnace conditions as nearly the same as it was possible to reproduce them in the ordinary operation of the plant. This curve shows that draft conditions vary

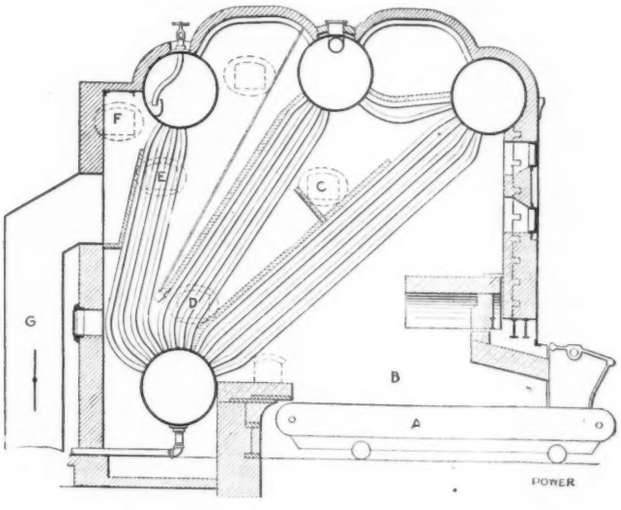


FIG. 2.

from time to time, although readings from the same plant under similar conditions will in a general way check closely.

The draft readings given for curves Nos. 2 to 5, inclusive, are not merely one set of readings, but are the average of several different observations. For example, a set of readings would be made as quickly as possible at the different points indicated. At intervals this work would be repeated until there were six or eight such sets of observations. These data were then averaged and the averages tabulated for record.

It is possible from what has been said for one to assume that all the baffling should be taken from the boiler, thereby increasing the draft intensity in the furnace to a maximum. It is true that such action might increase the fuel-burning capacity of the furnace to the utmost,

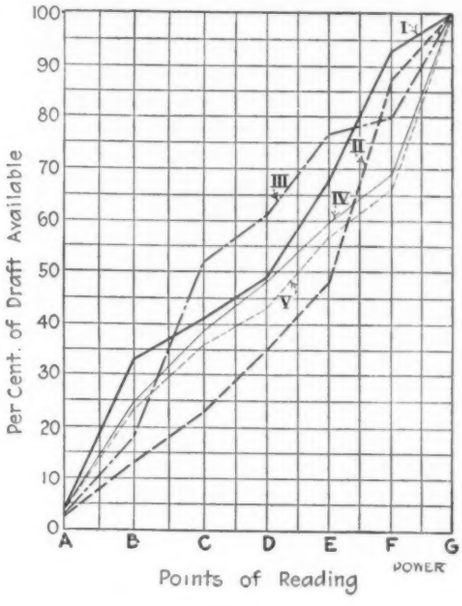


FIG. 3.

but the boiler efficiency would be low. The purpose of the baffling is to cause the heated gases to traverse the absorbing surface in such a manner as to give maximum efficiency of heat transfer. It must be borne in mind, though, that any one item in the operation of boilers can be carried to an extreme. Capacity and efficiency must be considered with relation to cost of installation, attendance, repairs, flexibility, etc. It has been found that the available draft through the average Stirling boiler with a fire 6 to 7 in. thick, using Middle Western coal with natural draft and giving satisfactory commercial returns, should be about as given in curve No. 1.

The course the writer usually pursues in analyzing draft conditions in a boiler is about as follows: Make several sets of observations of draft at the various points through the boiler. For this purpose use a draft gage constructed so that it can be read easily and accurately to hundredths of an inch. Find the average reading for each point as in Table 2. Consider the reading at the

TABLE 2—DRAFT INTENSITY THROUGH STIRLING SETTING IN HUNDREDTHS OF AN INCH WATER GAGE

No. of Curve	A	B	C	D	E	F	G	Date of Reading
2	2	8	14	21	29	58	60	Oct. 13, 1910
3	2	12	34	40	51	53	66	Oct. 20, 1910
4	2.5	16	25	31	39	45	65	Oct. 24, 1910
5	2.5	17	25	30	40	46	70	Oct. 28, 1910

stack side of the damper as 100 per cent. Calculate the ratios between the readings at the various points and at point *G*. Express these ratios in percentages as in Table 2, and construct curves similar to those shown in Fig. 3. For convenience of study, it may be advisable to make each curve a different color. Compare the curves thus found with the normal curve for the type of boiler under consideration. Draft troubles may then be quite easily corrected because quickly located.

Some Transformer Connections

By Gordon Fox

SYNOPSIS—How to determine the polarity of a transformer, connect it properly, and obtain the desired voltage combinations.

When two alternating-current circuits are to operate in parallel they must be in synchronism, which requires equality of voltage and frequency and coincidence of phase. It is not within the province of the stationary transformer to change frequencies so that only circuits of the same frequency can be paralleled. But transformers do change voltage and can easily change relative phase relations, so that where more than a single transformer is involved it is necessary to exercise considerable care to maintain the proper voltage and phase conditions.

Consider the case of two transformers connected in open delta as at *a* in Fig. 1. Here one phase is in a 60-degree relation to the other and the voltages of the secondary phases are all equal. Reversing one transformer secondary, as in *b*, changes its phase position 180 degrees, so that it now bears a 120-degree relation to the phase of the other transformer and the three secondary voltages are no longer equal.

Likewise in a three-phase three-transformer connection it is an easy matter to connect in one phase reversed; in fact, more so than with two transformers. For instance, Fig. 2-a shows three transformers of the same polarity connected properly in star and the phase relations are indicated. Reversing one of the secondary phases, an easy mistake, causes the voltage and phase relations to be entirely changed; this is shown in Fig. 2-b. Similarly, with two transformers of one polarity and the third of the opposite polarity connected as in Fig. 2-a, the phase relation of Fig. 2-b would be obtained.

The term polarity as applied to transformers refers to the relative location of the primary and secondary leads. The terms positive and negative polarity have been empirically chosen to represent the two possible relations of primary and secondary leads. A transformer is said to have positive polarity if, when a primary lead is instantaneously positive, the secondary opposite it in the case is instantaneously negative. Fig. 3-a shows diagrammatically the arrangement of coils in a transformer having positive polarity and indicates the relative instantaneous directions of the currents in the coils. This will be more evident in connection with an explanation of the test to determine polarity.

It is quite a simple procedure to test the polarity of a single-phase transformer. A voltmeter is desirable for the work but lamps can generally be used satisfactorily. The terminals are connected as in Fig. 3-b, one primary lead being connected to a secondary and the terminals *A* and *C* connected across a convenient low-tension, alternating-current line, say, 110 volts. Voltages *A-B*, *A-C* and *C-D* are then measured or their relative values determined with a lamp: If *A-C* is greater than *A-B*, the determined with a lamp. If *A-C* is greater than *A-B*, the it has negative polarity.

The polarity of transformers being determined, their relative phase relations must be kept constantly in mind when connecting them. This is best done in the case of single-phase circuits by making a rule to connect all positive polarity transformers with their leads straight and negative polarity transformers with their leads crossed. In the latter case, only one set of leads should be crossed, of course, preferably the secondaries. For the sake of uniformity it is well to adhere to a standard practice. Fig. 4 shows two transformers of positive polarity and one of negative polarity banked.

When single-phase transformers are connected on three-phase systems care must be used to preserve the proper phase relations. This can most easily be followed through if for individual cases the relative phase positions of the transformer windings are indicated on the diagram of connection. Fig. 5 represents a bank of three single-phase transformers connected in delta-star, showing the relative positions of the windings. The position of the primary windings may be arbitrarily selected, the selection being consistent with the actual physical connection. The secondary winding phase relations follow at once from the positions of the primary windings. It is then necessary only to figure the proper connection of the secondary to get the desired result.

To follow through the connections in Fig. 5, first assume that the transformers are all of like polarity; it really makes no difference whether they be positive or negative so long as they are all alike. If one transformer is of opposite polarity from the others, the same reasoning can be followed out and then the secondary of the differing transformer can be reversed. The primary three-phase wires are represented by *X*, *Y* and *Z*. Since the primary is to be delta connected, transformer No. 1 can be connected with its primary leads across any two of the primary wires; for instance, *X* and *Y*. Then the phase relation of the primary can be arbitrarily shown as designated *a-b*. Next connect the primary of transformer No. 2. These leads may be connected across either *Y-Z* or *X-Z*, the diagram showing the former. The phase relation is once more arbitrarily selected in such position that *b-c* makes a 60-electrical-degree angle with *b-a*. Next, connect the primaries of transformer No. 3. This transformer must now be connected between the wires *X* and *Z* to obtain the delta, the phase relation being represented by *a-c*, making 60 electrical degrees with *a-b* and the same with *c-b*.

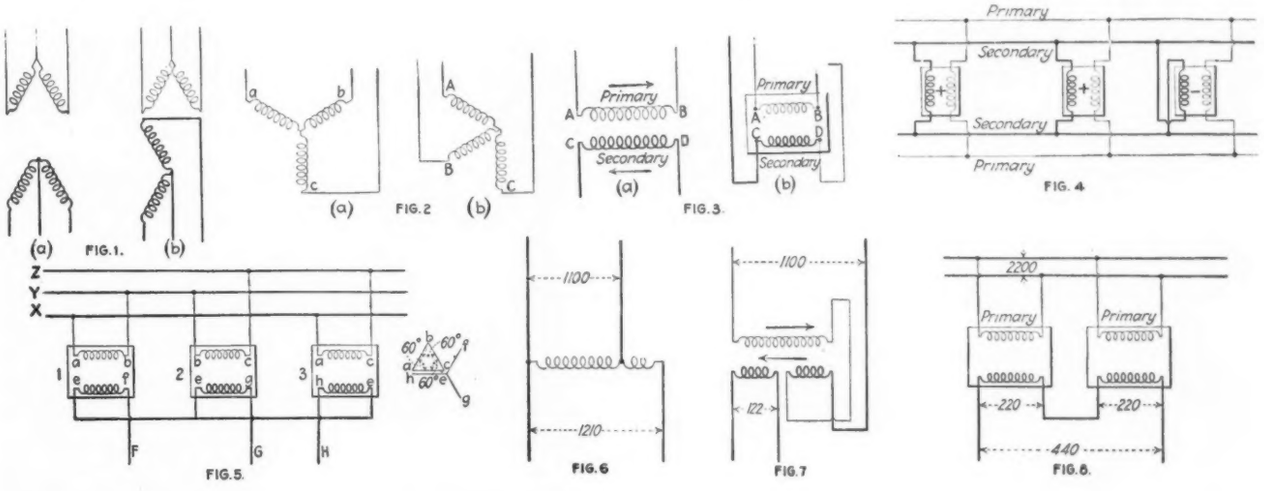
In making the secondary connections, it will be best to lay out the transformer-phase relations first and make the terminal connections to correspond. For a star connection such as desired, there must be 120 electrical degrees between phases. Lay off *e-f* parallel to *a-b*. This phase makes an angle of 60 degrees with the horizontal and 30 degrees with the vertical. In transformer No. 2, *e-g* makes a 60-degree angle with the horizontal and a 30-degree angle with the vertical. By placing the points *e-e* to coincide, the desired relation is obtained between the phases of these first two transformers, namely, 120 degrees.

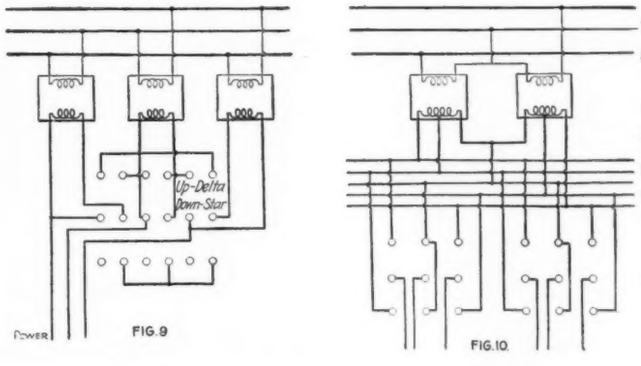
Next, consider transformer No. 3. This phase, graphically represented, must extend horizontally to the left, and will do so if lettered as shown. Since the points *e-e-e* form the star in the diagram they will do so in the ac-

tual connection. The leads *F-G-H* are the three-phase wires for the secondary circuit.

In a similar manner, a delta to delta, star to star, or star to delta connection can be laid out and connected. A little study in laying out the diagram will save time and trouble and will assure a correct connection at the first trial.

Not infrequently it is desired, for testing or other purposes, to secure a voltage other than standard. Figs. 6, 7 and 8 show three arrangements of single-phase transformers which may be used in emergencies or for special purposes. Fig. 6 shows an auto-transformer connection for securing a 10 per cent. boost in the line voltage. Fig. 7 is a step-down arrangement providing a higher secondary voltage than that resulting from the ordinary





VARIOUS TRANSFORMER COMBINATIONS

transformer connection. In this case half the secondary is connected bucking the primary, thus reducing the effective primary turns and decreasing the ratio of transformation proportionately. The capacity of the transformer is cut nearly in two since only half the secondary is available to carry secondary load. In the case cited, with a ratio of transformation of 5 to 1, the voltage across one-half the secondary would be 110 with the usual connections; whereas, with the connections shown, it would be 122. Where the ratio of transformation is high, the difference would be small. A connection similar to that of Fig. 7, in which half the secondary is made to boost the number of effective primary turns, would change the transformation ratio so that a voltage of 100 would result in the other secondary coil, providing the original ratio was 5 to 1 and the primary voltage remained the same.

Fig. 8 is an arrangement utilizing two transformers with the primaries in parallel and secondaries in series to give double the rated voltage of the transformer secondaries. An arrangement of this sort could be easily made to utilize transformers on hand in a plant where an increase in voltage is desired.

Sometimes in connection with three-phase work it is desirable to obtain a range of voltage. This can be done within certain limits by manipulating the connections. With a given primary connection the secondary star connection provides 1.73 times the voltage from the delta connection. By changing both primary and secondary for both arrangements and utilizing various combinations, quite a flexible and broad voltage range is attainable.

Assume three single-phase transformers with 2300-volt primary windings and 115-230-volt secondaries. The table shows the number of available three-phase secondary voltages which can be secured by different connections. If the transformers are provided with 10 per

TABLE OF TRANSFORMER CONNECTIONS

Primary Connection	Secondary Connection	Primary Volts	Secondary Volts	Remarks
Star	Open delta	2300	66 or 115	Using middle taps of two transformers.
Star	Star	2300	115	Using all middle taps.
Star	Delta	2300	133	Outside terminals.
Delta	Star	2300	199	Using all middle taps.
Delta	Delta	2300	230	Outside terminals.
Delta	Star	2300	398	Outside terminals.

cent. taps, as most standard transformers now are, the range can be still further enhanced. With such a number of connections it may appear difficult to make the necessary changes. Fig. 9 shows a switch arranged to make it possible to change easily from star to delta and *vice versa*. A little study will make the connection plain. By providing such a switch in both primary and secondary circuits the changes can be quickly made.

One case in which an arrangement of this kind sometimes proves useful is to provide reduced starting voltages for motors. If there be but a single large motor fed from a transformer bank, it may be feasible to do away with an expensive compensator by simply connecting the transformer secondaries in delta at starting and then throwing over to star for running. The ratio of torques compares with the lowest point on ordinary com-

pensators. This arrangement is not suitable where more than one motor is involved. Another arrangement which can be used for a number of motors is shown in Fig. 10. This is merely an open delta in which the 50 per cent. taps are used to secure the lower starting voltage. Since the starting torque of motors at 50 per cent voltage is low, this arrangement cannot be used where heavy starting duty is required. The additional wiring may prohibit its use for an extensive system, but in not infrequent cases it can be, and is, used to advantage.

Lack of Synchronism in Check-Valve Action

By S. F. Jeter

In the changes in the Massachusetts boiler rules, as given in the issue of Sept. 15, p. 395, under Section 2, paragraph 25, it is proposed to require a separate check valve on the return pipe to each boiler instead of one check valve on the main return pipe, as is now the rule.

Such a change would certainly be a step in the wrong direction, for it has been amply demonstrated in practice that check valves arranged in parallel cannot be expected to act in synchronism under small differences in pressure. The failure of these valves to act in unison is due to a tendency to bind and a slight difference in the weight of the valves where they are of the same size; but chiefly

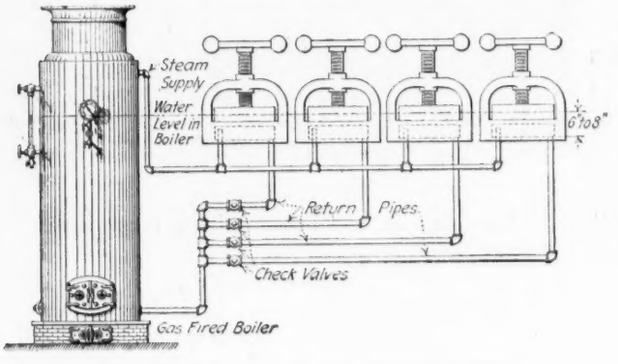


Fig. 1. The Original Installation

due to the differences in area exposed to pressure on the two sides of the valve produced by the difference in the amount of seated area in valves of the same size. In the case of valves of different sizes the difference in the ratio between the seated and the effective area under the valve causes the failure of such valves to act in unison. I recently observed a case of trouble resulting from this cause, which aptly illustrates the difficulties that may be expected if this change is made in the rules.

An establishment which required heated platens for a series of presses had an automatic gas-fired boiler to furnish the steam during the summer months in place of the larger boiler. The original arrangement was as shown in Fig. 1, where the normal water line in the boiler was about six to eight inches above the steam spaces in the presses. It was advised that there should be installed a pump or some form of lifting trap (since it was impractical to lower the boiler) in order to get steam into the platens of the presses, as was required. A tilting trap was installed (Fig. 2), but the apparatus failed to operate properly. The trouble was that the water line in the boiler would drop rapidly and get entirely out of sight in the glass, which would necessitate closing down, as the boiler's water capacity was limited. Any tendency of the water stopping at any point in the system would lower the water line to a dangerous point.

It was decided that the check valves on the returns did not act in unison and that water collected in one or more of the platens due to the failure of the check valves to open. The separate return pipes were replaced with a single pipe and check (Fig. 3) and the trouble was removed. The distance from the bottoms of the platens to the level of the return pipes where the check valves were

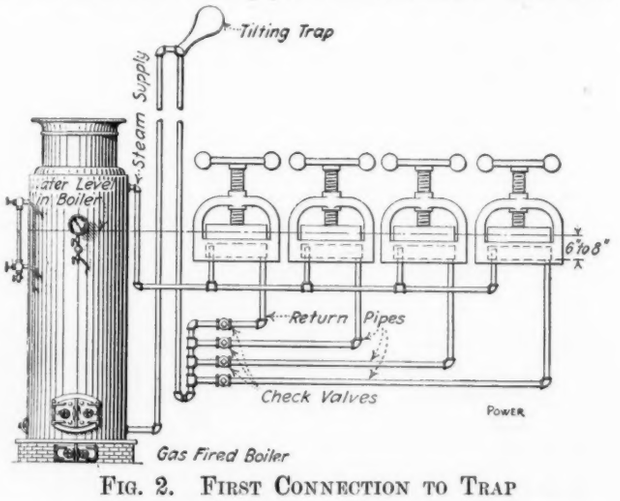


Fig. 2. First Connection to Trap

located was about fourteen inches, which clearly demonstrated that these particular check valves, which were all of the same size and make and were purchased at the same time, could not be relied on to work nearly enough in unison to prevent a change in water level of fourteen inches. No water could begin to collect in the platens until this difference of level was maintained by one or more of the check valves failing to operate under this head.

Differences of water level considerably less than the above would be dangerous in many kinds of heating boil-

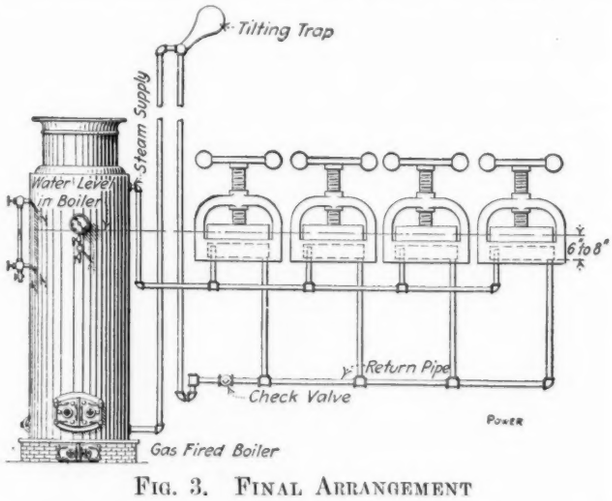


Fig. 3. Final Arrangement

ers. Of course, with a single check valve for several boilers there is the risk that the attendant may close the steam valve on a boiler without closing the stop valve on the individual return pipe to the same boiler, but that danger is less than the danger from the condition mentioned. A better arrangement than either would be to have the return connections located at or above the lowest safe-water line, as was suggested in the issue of July 28, p. 133.

Standard Iron Co.'s Steam-Turbine Power Plant

By O. C. Thomas

SYNOPSIS—The charcoal-iron manufacturing plant of the Standard Iron Co., Ltd., is on an inlet of Georgian Bay, at Perry Sound, Ont. The power house is of interest in possessing a turbo-blower and in the variety of purposes to which steam turbines have been applied. Although furnace gas was available, the convenience of gas-fired boilers and the direct rotary drive of steam turbines, together with ease of starting up, made turbines preferable to gas engines.

The steam generators of this plant, Fig. 1, consist of three flush-front, horizontal return-tubular boilers having furnaces designed for either coal or blast-furnace gas. Each boiler is rated at 200 hp. and has 2000 sq.ft. of heating surface; the shell dimensions are 78 in. diameter by 20 ft. long. The boilers are designed for a working pressure of 150 lb., in accordance with the Massachusetts boiler rules. The products of combustion are discharged into a 5-ft. diameter, 125-ft. guyed stack.

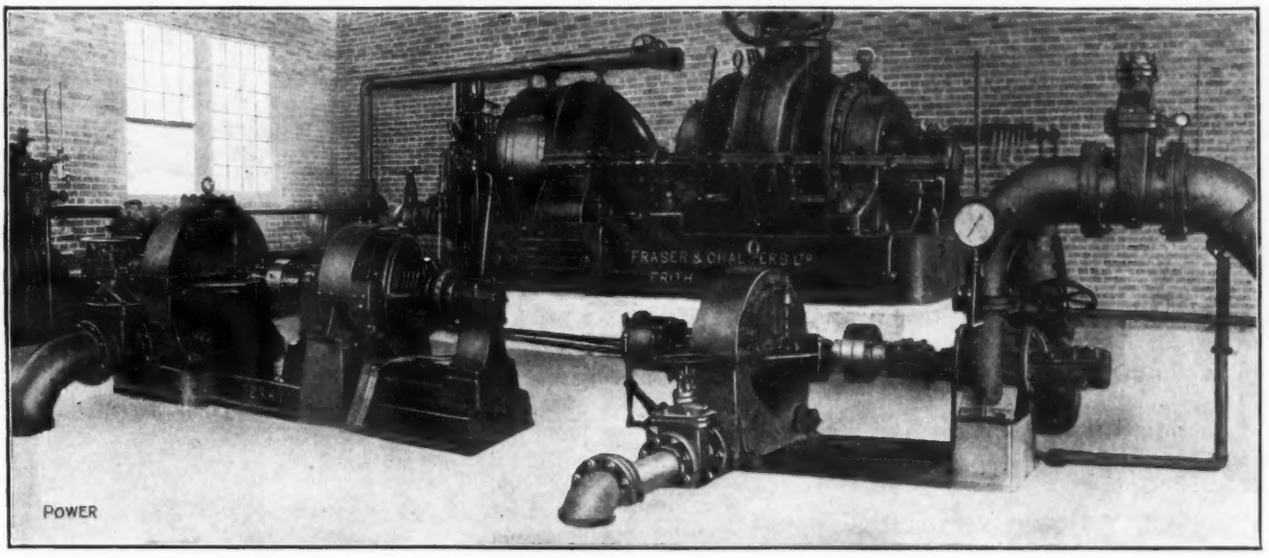


Fig. 1. Turbine-Driven Blower, Generator and Condenser Water-Removal Pump

Steam Turbo-Blower

For supplying air blast to the furnace a turbine-driven blower is employed with a capacity of 12,000 cu.ft. of free air per min. delivered at from 6 to 8 lb. per square inch and running at 4000 r.p.m. All bearings are fitted with forced lubrication, oil being delivered from a gear pump driven from the main shaft and circulated through an oil cooler and filter before being returned to the bearings.

Air is taken in through a ¼-in. mesh wire-gauze screen and filter outside the building and carried in a duct under the turbine-room floor to the blower. There are non-return and relief valves in the air main to the furnace. The turbine end of the blowing unit consists of an impulse steam turbine, taking saturated steam at a boiler pressure of 150 lb. and exhausting into a low-level jet condenser at 28-in. vacuum, referred to 30-in. barometer. The steam consumption is 13.9 lb. per brake-horsepower-hour. Noncondensing working is provided for by a 10-in. "Multiflex" atmospheric relief valve and a gate valve for isolating the condenser. A steam separator is placed between the turbine and the lowest point in the main steam header. The overall dimensions of the turbo-blower are 5 ft. and 15 ft. by 6 ft. 2 in. in height from the bottom of the bedplate.

For driving the removal pump of the jet condenser, a 14-hp. steam turbine is used, running at 1850 r.p.m. The condenser is placed in a basement below the turbine to facilitate the flow of injection water. The vacuum is maintained by an engine-driven dry-air pump, shown at the left of Fig. 1.

Electrical and Pumping Equipment

Other apparatus in the power house includes a 40-kw. turbo-generator for lighting and power purposes, one 5- and one 8-in. turbine-driven centrifugal pump, two duplex outside-packed boiler-feed pumps, and a closed feed-water heater, through which the auxiliary units exhaust their steam. The 40-kw. direct-current generator runs at 2800 r.p.m., being driven by a noncondensing steam turbine taking 37½ lb. of steam per brake-horsepower. The 5- and 8-in. centrifugal pumps driven by turbines are for general service and deliver cooling water to the furnace.

The 40-hp. turbine driving the 5-in. pump takes 1500 lb. of steam per hour noncondensing. These pumps, together with the condenser, draw their water from a 14-in. suction main running from the bay, 256 ft. from the power house. The lake-water level is 15 ft. 6 in. below the centrifugal-pump centers and 13 ft. below the conden-

ser-injection inlet. The pumps are primed by a steam ejector.

The two duplex feed pumps have normal capacities of 108 gal. per min. each and are situated in the boiler room; they are arranged to draw water either from the condenser hotwell or from the main centrifugal pump-suction line. The feed-pump discharge is led through the feed-water heater on its way to the boilers, a bypass cutting out the heater for cleaning, etc.

Steam is conducted from each boiler by a 6-in. branch and an isolating valve leading into a 6-in. steam main to the turbine room, where, by a vertical drop of 17 ft., the pipe passes to the level of the trenches in the concrete floor, through which the branches to the different units are led. The vertical length of main does away with any necessity for an expansion bend and facilitates

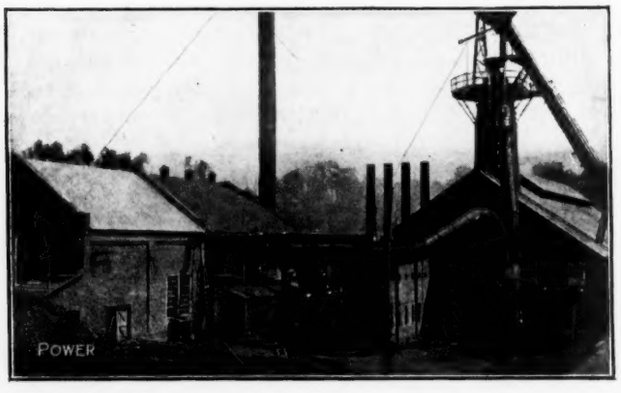


FIG. 2. POWER HOUSE AND PIPING TO FURNACE

drainage, which is designed to gravitate toward the steam separator. Water of condensation is removed by an automatic steam trap directly attached to the separator. Although steam piping in trenches is not usually advantageous, the fact that in this instance all the turbines are placed above the piping renders remote the chance of damage by water. The high-pressure main and branches above 2½-in. in diameter are of extra-heavy, wrought-steel pipe with screwed-on flanges. For 2½-in. diameter and less, screwed fittings are used.

The blower turbine is connected to the condenser by a cast-iron exhaust bend and a corrugated copper expansion joint. All the other units exhaust into a galvanized wrought-steel exhaust main connected to the feed heater. Isolation of the heater is attained by closing a gate valve next to the heater and opening another on the exhaust main leading to the atmosphere. These valves will also be used in cold weather to build up a slight back pressure for exhaust-steam heating. A relief valve is fitted to the main in a conspicuous position to draw attention to any undue rise in pressure.

The water connections to the centrifugal pumps and condenser are of cast-iron flanged pipe with long-radius elbows, and taper pipes make connections with the pump branches. The main suction line is of flanged piping, and was tested for air leaks to a pressure of 30 lb. per sq.in.

In addition to a necessary foot valve at the intake, check valves are placed in the branches to the condenser and feed pumps, and there are water-sealed gate valves in the branches to the centrifugal pumps. The velocity of water in the suction main under normal operating conditions is 280 ft. per min., and the friction head loss between the lake and the pumps is estimated at about 2.7 ft., omitting the resistance of the foot valve.

A solid rock formation immediately below the engine-room floor made it inexpedient to place the power house at a lower level, and prohibited the construction of an intake flume. The satisfactory working of the present arrangement shows that any other scheme would have been an unnecessary expense. The feed piping to the boilers is extra heavy, similar to the main steam piping, and each branch to a boiler has the usual stop, check and feed-regulating valves, the latter arranged at the front of each boiler at hand level. With two exceptions, all water and feed valves are of the straightway type.

The plant was started up and the blast furnace, Fig. 2, "blown in" on Aug. 21, 1913, and on Aug. 24 the furnace was tapped and several tons of charcoal pig-iron drawn off. The simplicity of operation of this power plant is worthy of comment. In the first place, the boilers are gas fired and therefore need but little attention. The only reciprocating motive power is that driving the air pump, and it is automatically oiled. As the rest of the apparatus is steam-turbine driven, the whole plant can be easily operated by one man, and his duties are practically limited to watching the feed water and keeping the log book entered up.

The contractors for the equipment were the Rudel-Belknap Machinery Co., Ltd., Montreal; the turbines were supplied and erected by Fraser & Chalmers of Canada, Ltd., Montreal.

Tricks of the Trade

BY F. W. HARRIS

Thompson was a passenger- and freight-elevator salesman selling both hydraulic and electric elevators. He not only sold elevators for new buildings, but he would sell an electric to replace a hydraulic elevator, giving incontrovertible reasons to justify the change. He would also sell a hydraulic elevator to replace an electric, and give equally solid data to justify this change. In fact, he was a true salesman.

He had been after old John True for a long time to get him to throw out a "worthless" hydraulic machine and put in an electric, and he was spurred on by the fact that he had a customer who had a "worthless" electric elevator which he planned to replace by a hydraulic.

Thompson found, by spending a little money on cartage and erection and furnishing a little additional material, that the shift could be made with profit to himself and temporary satisfaction to both customers.

Old John operated his hydraulic elevator from the city water mains and Thompson visited the water bureau.

"I am from True & Sons," he stated. "We have mislaid our bills for the last two years and I wondered if I could get a statement of the amounts for these years."

He found that the bill for two years was $195. Old John refused to be convinced by his arguments and particularly scouted the claim of lower cost for the electric. "You don't know what it costs me to run my elevator," he objected; "you are just guessing at it."

"Not exactly guessing, Mr. True. We elevator men can figure closely. Now, I know the distance you have to lift and I can give a close estimate of the average load carried and the number of trips made per day. I know

the water rate in this city and the rest is a mere matter of higher mathematics."

Old John looked at him over his glasses and growled: "Higher mathematics, eh! And what do you make it by your higher mathematics?"

"Well, considering general business conditions during the last two years, your water bill should have been a little under $200 for the two years; say $195."

"Wait a minute until I get the bills."

The old man went over the file slowly and finally came back with two bills which he totaled. Then he looked over his spectacles at Thompson with a new respect in his eyes.

"Say," he said, "you are surely a close figurer. It cost exactly $195."

Whereupon Thompson got out his orderbook.

Small Isolated Plant Pays Big Dividends

By Thomas Wilson

SYNOPSIS—This small plant, which is earning from 17 to 21 per cent. on the original investment after fourteen years of service, is equipped with high-speed engines and practically all of the exhaust steam is utilized.

From central-station sources it has been frequently stated that the commercial life of a plant should be limited to fifteen years. There is no doubt that some plants are ready for the scrap pile at the end of this period and that others might better be equipped with more efficient machinery, but in the majority of isolated plants the time of usefulness and efficiency far exceeds the limit named. This is particularly true where heating is to be done. Where there is use for the exhaust steam the engine rate is not of prime importance, for if the supply of exhaust is curtailed, live steam from the boilers must fill the demand and the total is as high as ever.

A plant which has been in use for fourteen years in a

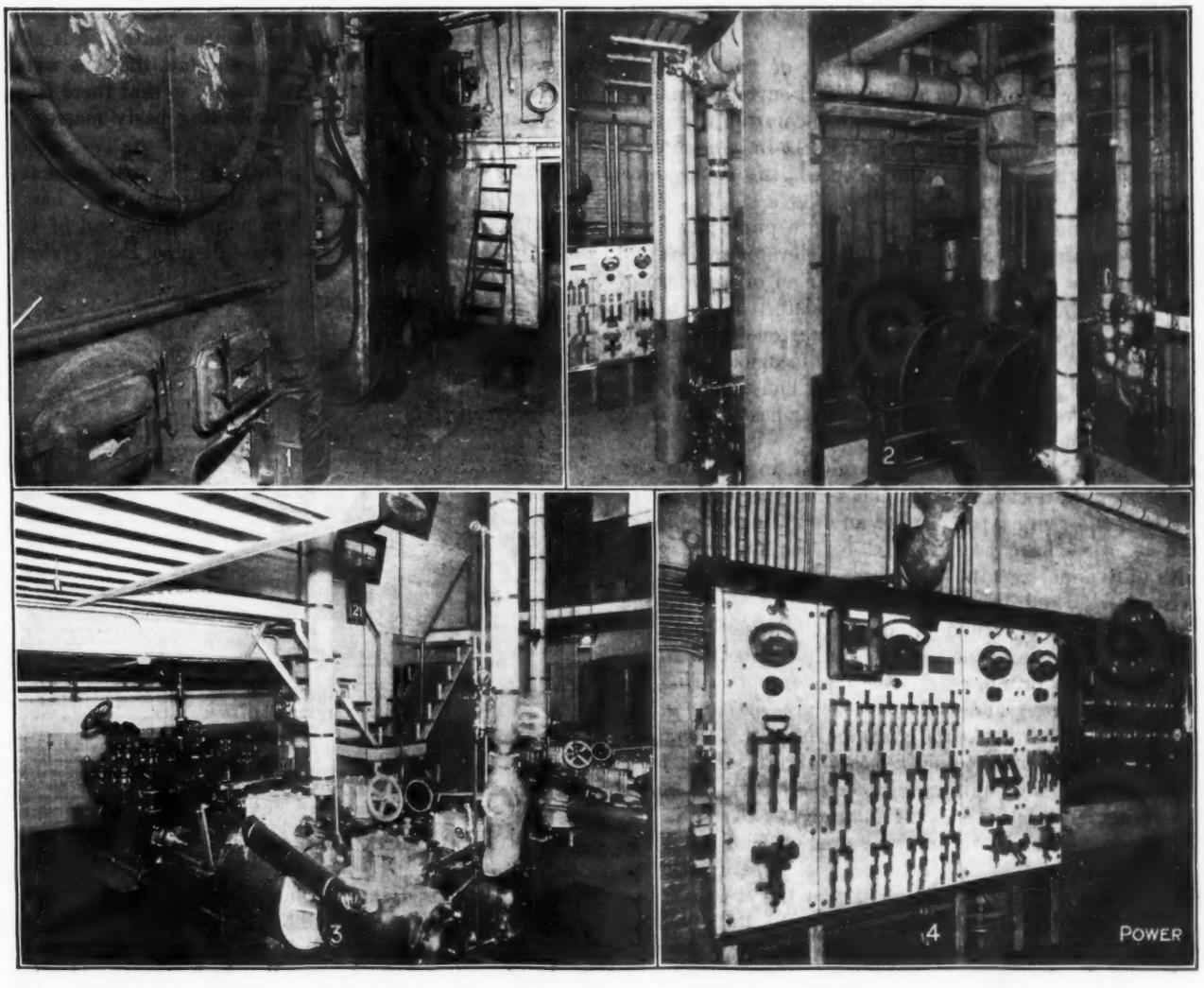


Fig. 1. The Two Return-Tubular Boilers. Fig. 2. A View of the Generating Units. Fig. 3. Tandem-Compound Elevator Pumps. Fig. 4. Switchboard and Gage Panel

Northern city and is good for as many more is here described. The casual observer would think that the plant is only four or five years old as the engines, pumps and accessories have the freshly painted appearance of being new and are in the best of condition. Besides, an examination of the records shows that the plant is as efficient as many of more recent design.

The firm does a wholesale hardware business, and makes harness, awnings, tents and does some forge work. It has two large frame buildings from two to eight stories high. In plan, the main building measures 420 ft. on

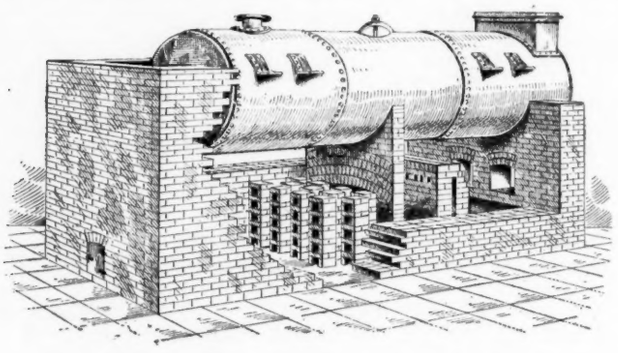


FIG. 5. TYPE OF BOILER SETTING USED

one side, 450 ft. on the other and is 100 ft. wide. The other building is 125x140 ft.

The equipment consists principally of two 72-in. by 20-ft. tubular boilers; two 75-kw. direct-current dynamos, each driven by 11x18x14-in. tandem-compound engines running at 270 r.p.m.; one simple 11x12-in. engine driving a 45-kw. machine at the same speed; two feed pumps, one a 7x4¾x8-in. duplex and the other a simplex, 7⅝x 4½x9-in.; one duplex 18x10x12-in. fire pump; two 12x 4½x18-in. tandem-compound duplex elevator pumps and six hydraulic elevators operated under an oil pressure of 800 lb. in connection with an accumulator. Four of the elevators are rated at three tons, one at one ton and the other at 1500 lb. There are also some locomotive-type air compressors, a 5¼x4¾x5-in. duplex house pump, one 8x12x12-in. vacuum pump, a feed-water heater and some minor equipment.

The fire-tube boilers (Fig. 1) are 6 ft. in diameter and 20 ft. long, have seventy 4-in. tubes and the joints are of the butt-and-strap type. Under an operating pressure of 125 lb., they have been worked for the fourteen years with only minor repairs. The water, obtained partly from driven wells and from a bay, is of good quality, and a small amount of compound, costing about $25 per year, has been used to keep the boilers clean. One boiler, forced at times above rating, carries the load except during the coldest weather. Under the boilers are shaking grates measuring 6x5 ft. To the grate surface of 30 sq.ft., a heating surface of 1740 sq.ft. bears a ratio of 58 to 1. The breeching is of uniform size, 4 ft. square, and enters a rectangular brick stack, 7x4 ft. and 140 ft. high. To the connected grate surface the area of the breeching bears a ratio of 1 to 3.75 and the stack area a ratio approximating 1 to 2. It is evident that the cross-sections of both breeching and stack are abundantly large, but no doubt some allowance has been made for the higher resistances of square passages.

Semibituminous egg coal is delivered by rail and dumped from cars on a siding into a hopper underneath the track. It is raised by a chain belt of home manufacture to a bin in front of the boilers and hand-fired onto the grates. There are two doors to each furnace and the alternate method of firing is used.

The furnace is of the special design shown in Fig. 5. It consists first of a hollow bridge-wall with an opening leading out under the grate. Near the top and at the back of the bridge-wall heated air passes out through a series of openings to mix with the gases of combustion and supply sufficient oxygen for the volatile. In the firing doors there is provision for admitting air over the fire; the boilers are operated with the ash doors removed. Back of the bridge-wall and extending down from the boiler shell is an arch under which the gases must pass into a checkerwork of brick piers. The latter maintain a high temperature in the combustion chamber so that the gases, mixed thoroughly in their passage under the arch and among the piers, burn at a high rate of combustion.

Water for the boilers in the heating season comes from a tank receiving the returns of the heating system. By means of a ball and float, makeup water is supplied from the house tank on the seventh floor. Duplex-feed pumps force the water to the boilers through a vertical closed heater 30 in. diameter and 12½ ft. high and a single-pipe economizer in the breeching 2 in. diameter and 60 ft. long. In the heater the temperature of the water reaches 150 deg. and is raised to 204 by the economizer. That the latter has been in service nine years and is still in good condition is attributed to the fact that the water enters the pipe hot (150 deg. at least), so that there is no opportunity for sweating and collecting pasty masses of soot on the exterior.

Heating is required nine months in the year from the 23,500 sq.ft. of radiation. The smaller building has a two-pipe system with a vacuum pump at the end of the line; the main building has a single-pipe Paul system.

DAILY REPORT OF POWER PLANT

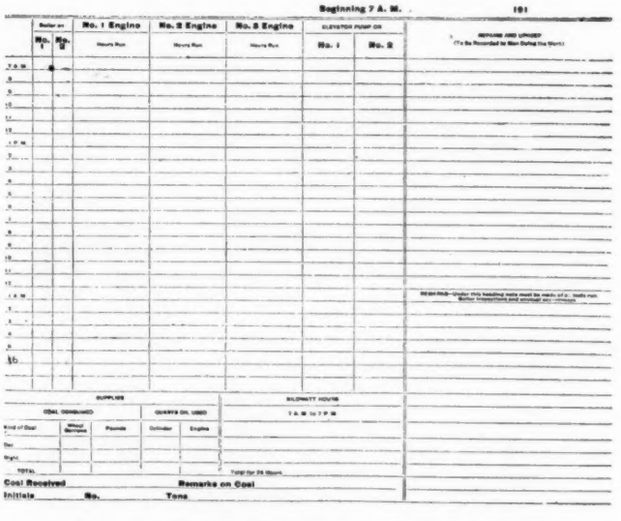


FIG. 6. BLANK FORM FOR THE DAILY LOG

Radiators are used in the office, the temperature being controlled by thermostats. For six months there is sufficient exhaust steam during the day to do all of the heating besides supplying a large collar-drying room and raising the temperature of the water for boiler feed and house use. During the three coldest months some live steam is

required, and at night throughout the cold season it is necessary to draw on the boilers, as the load is always light and the supply of exhaust steam is limited. The conditions then are unusually favorable. For nine months in the year, all of the exhaust steam is utilized and during the remaining three months part of the available supply goes to the feed-water heater, the drying room and the hot-water tank.

For ten hours the load averages about 650 amp., although it fluctuates considerably, due to the throwing on and off of some of the larger motors. After 10 o'clock at night and on Sundays it is only nominal. The connected load is 130 motors, these totaling only 208 hp., as many of them are used on sewing-machines, stitchers, envelope-sealers, adding machines, etc., and consequently are of small size. All operate at 110 volts and with the exception of a few shunt machines are compound wound. For illumination there are, in round numbers, 5000 sixteen-candlepower lamps.

It has been the custom to run one of the compound-engine units for the greater part of the day. From 3 to 5:30 p.m., during the peak load, and on dark days the simple engine is used to help out, and after 10 in the evening it is the only engine running.

TABLE 1. POWER PLANT EXPENSES AND EARNINGS AT CURRENT RATES FOR 1911

Expenses

Coal, $3.45 per ton	$4,653.57
Switching and unloading	180.00
Engine oil used for all purposes	40.00
Cylinder oil	86.36
Grease for engines and motors	1.05
Hydraulic oil for elevators	56.52
Waste for engines, elevators and motors	56.52
Engine repair	70.81
Boiler repair	7.55
One-half of chief engineer's salary	800.00
Second engineer's salary	1,033.75
Two firemen's salaries	1,678.90
Paint and varnish	6.00
Fixed charges: Interest, 5%; depreciation, 5%; insurance and taxes, 1% on plant cost of $30,000	3,300.00
Total expenses and charges	$11,971.03

Earnings

Current at 3c. per Kw.-Hr.	Kw.-Hr.	
January	23,423	$702.69
February	18,950	568.50
March	22,710	681.30
April	20,097	602.91
May	20,090	602.70
June	17,204	516.12
July	18,343	550.29
August	20,612	618.36
September	18,327	549.81
October	20,823	624.69
November	20,427	612.81
December	23,423	702.69
Total	244,429	$7,332.87
Heating; 23,500 sq.ft., at 30c.		7,050.00
Six hydraulic elevators, 300 working days, at $7 a day		2,100.00
Water pumped at 2c. per 100 cu.ft.		504.00
Fire pump maintenance for one year		78.00
Live steam to factory		56.00
Hot water for house service		78.00
Total earnings		$17,198.87
Total expenses		11,971.03
Net earnings		$5,227.84

TABLE 2. POWER PLANT EXPENSES AND EARNINGS AT CURRENT RATES FOR 1912

Expenses

Coal, $3.45 per ton	$5,111.43
Switching and unloading	211.50
Engine oil used for all purposes	52.61
Cylinder oil	83.60
Grease for engines and elevators	4.20
Waste	35.41
Boiler compound	25.70
Boiler repairs, brick setting	95.40
No. 2 engine overhauled	195.60
Other repairs	32.88
Packing for engines and elevators	9.29
Paint for engine room	20.26
Metal polish	0.72
Tools	8.50
Half of chief engineer's salary	850.00
Second engineer's and two firemen's wages	2,623.77
Fixed charges: Interest, 5%; insurance and taxes, 1%; depreciation 5% on plant cost of $30,000	3,300.00
Total expenses and charges	$12,660.87

Earnings

Current at 3c. per Kw.-Hr.	Kw.-Hr.	
January	28,327	$849.81
February	25,047	751.41
March	25,650	769.50
April	24,337	730.11
May	25,167	755.01
June	22,563	676.89
July	23,783	713.49
August	25,390	761.70
September	26,590	797.70
October	26,270	788.10
November	26,270	788.10
December	27,243	817.29
Total	306,637	$9,199.11
Heating; 23,500 sq.ft., at 30c.		7,050.00
Six hydraulic elevators, 300 working days, at $7 a day		2,100.00
Water pumped for building at 2c. per 100 cu.ft.		504.00
Fire pump maintenance for year		78.00
Live steam to factory		100.00
Hot water for house service		80.00
Total earnings		$19,111.11
Total expenses		12,660.87
Net earnings		$6,450.24

PRINCIPAL EQUIPMENT OF THE ISOLATED PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Boilers	Fire-tube	72-in.x20-ft	Generate steam	Natural draft, hand fired, 125 lb. gage	Northwestern Boiler Wks.
2	Furnaces	Reekie smokeless		Under boilers		J. D. Reekie of Duluth
2	Grates	Shaking	6x5-ft.	Under boilers		Beck
1	Heater	Inclosed vertical	30 in. dia., 12½ ft. high	Heat feed water	Exhaust steam, water 150 deg.	Kewanee Boiler Co.
1	Pump	Duplex	7x4½x8-in.	Boiler feed water	125 lb. steam	Fred M. Prescott Steam Pump Co.
1	Pump	Simplex	7½x4½x9-in.	Boiler feed water	125 lb. steam	Union Steam Pump Co.
1	Pump	Simplex	8x12x12-in.	Vacuum on heating system	125 lb. steam	Union Steam Pump Co.
2	Pumps	Tandem comp. duplex	12x4½x18-in.	On hydraulic elevators	125 lb. steam	Fred M. Prescott Steam Pump Co.
1	Pump	Duplex	18x10x12-in.	Fire	70 r.p.m., 125 lb. steam, 1000 gal. per min.	Fairbanks Morse & Co.
1	Pump	Duplex	5½x4½x5-in.	House pump	125 lb. steam	Gardner Governor Co.
6	Elevators	Hydraulic	Four 3-ton; one 1-ton, one 1500 lb.	Passenger and freight	Oil pressure 800 lb., 150 ft. per min.	Otis Elevator Co.
1	Pump	Duplex	4½x2½x4-in.	Oil for elevators	125 lb. steam	Fred M. Prescott Steam Pump Co.
1	Air compressor	Simple, locomotive type	9x6½x9-in.	Air chamber of elevator system	Steam 125 lb., air 150 lb.	Westinghouse Air Brake Co.
2	Engines	Tandem compound	11x18x14-in.	Main units	Steam 125 lb., 270 r.p.m.	A. L. Ide & Sons
2	Generators	Direct-current	75-kw.	Main units	115 volts, 270 r.p.m.	General Electric Co.
1	Engine	Simple	11x12-in.	Main unit	125 lb. steam, 270 r.p.m.	A. L. Ide & Sons
1	Generator	Direct-current	45-kw.	Main unit	115 volts, 270 r.p.m.	General Electric Co.

Fig. 6 illustrates the daily report sheet used at the plant. The accompanying tables show the operating costs for 1911 and 1912 under the conditions just enumerated and the earnings when charging current rates for the same services. In computing the expenses only half of the chief engineer's salary was charged, as but half of his time is devoted to the plant. The fixed charges are those prevalent in the city, as are the rates assumed for

electric current and heating. The rate of $7 per day for the six elevators is an estimate, as is the 2c. per 100 cu.ft. for pumping. In 1911, the plant paid a dividend of $5227.84 on an initial cost of $30,000. This is a dividend of 17.4 per cent. For 1912, a net earning of $6450.24 raised the percentage to 21.5, figured on the original investment, with no reduction to the depreciated value. To the present value of the plant the earnings would bear a much higher ratio.

To arrive at the cost per unit of generating current is difficult, as the steam for the pumps and engines has not been separated; the same applies to the labor and supplies. An approximation would be to deduct the earnings for other services from the total expenses and divide by the kilowatt-hour output. For 1911, the balance left for the generating plant would be

$$\$11{,}971.03 - \$9866 = \$2105.03$$

Dividing by the output, 244,429 kw.-hr., gives

$$\$2105.03 \div 244{,}429 = \$0.0086 = 0.86\text{c. } \textit{per kw.-hr.}$$

For 1912, the balance would be

$$\$12{,}660.87 - \$9912 = \$2748.87$$

Dividing by the output gives a cost per kilowatt-hour of

$$\$2748.87 \div 306{,}637 = \$0.00896 = 0.896\text{c.}$$

While these figures are only an approximation, they show that the plant is giving good service and that its commercial life is not seriously endangered.

Reconstructing Water-Tube Boiler Settings*

By Osborn Monnett†

SYNOPSIS—With a hand-fired furnace the boiler should be horizontally baffled, and department No. 8 furnace is recommended. Some interesting low-headroom installations.

Cleaning up hand-fired settings in connection with water-tube boilers is comparatively simple if the boilers are of the horizontally baffled type, as ordinarily there is enough headroom for a good hand-fired furnace and the proper combustion-chamber areas. In working over this kind of setting, the No. 8 furnace should be used. (For reference, see page 266 of the Aug. 25 issue.) Vertical baffles in a water-tube boiler must be horizontal before there is any hope of cleaning up the setting.

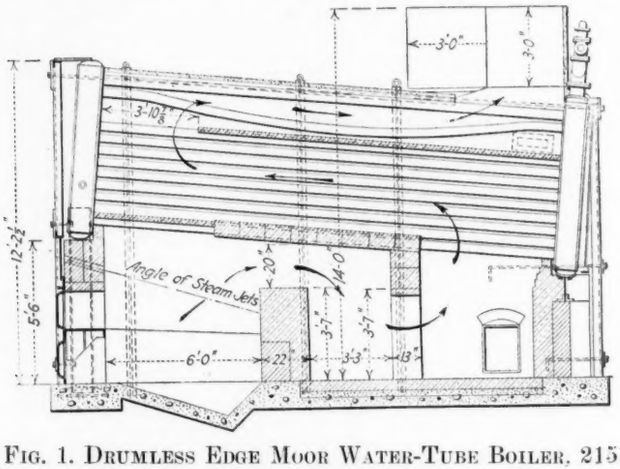


Fig. 1. Drumless Edge Moor Water-Tube Boiler, 215 Hp., and Hand-Fired Furnace

Sometimes an installation must be made under restricted headroom, particularly in office-building plants where the architect usually neglects the boiler-room space until the construction has gone so far that no adequate headroom is available. There are, of course, other circumstances that sometimes govern the doing of low-headroom jobs on new work.

Fig. 1 is a typical installation which, as an afterthought, was made in a modern office building. The original intention was to use central heating service. There was 14 ft. for headroom and the problem was solved by installing a drumless Edge Moor boiler with a combination T and box tile hand-fired furnace, having the deflection arch described in previous articles. The dis-

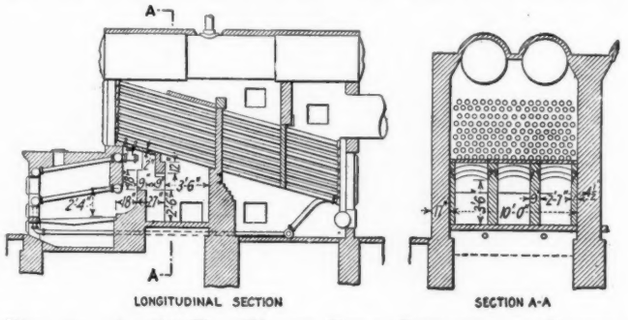


Fig. 2. A 400-Hp. Water-Tube Boiler and Down-Draft Furnace with Sprung Arch to Provide Travel and Mixture

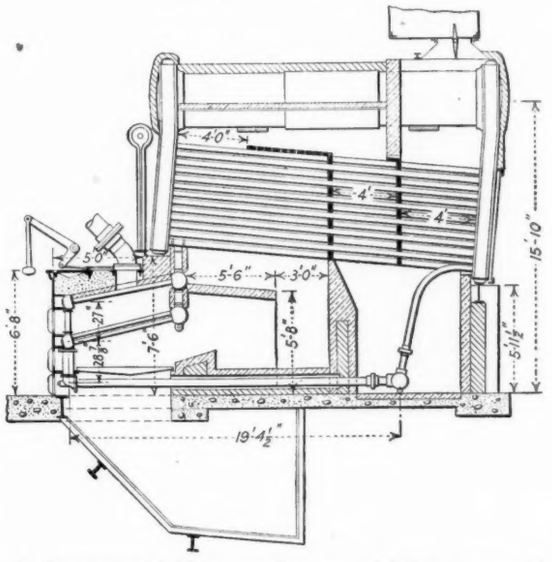


Fig. 3. Babcock & Wilcox Boiler, 300 Hp., with Full Extension Down-Draft Furnace and Mixing Arches

*Copyright, 1914, by Osborn Monnett.
†Smoke Inspector, City of Chicago.

tance from the floor to the bottom of the front header was 5 ft. 6 in., and from the top of the front header to the floor it was 12 ft. 2½ in. With proper operation this setting can be expected to give good results.

Vertically baffled water-tube boilers are sometimes equipped with down-draft furnaces, both full extension and flush front, but the combination generally makes a bad smoker. The flush front setting must be horizontally baffled before it can be cleaned up. With the full-extension furnace it is possible to interpose brickwork construction which will increase the flame travel and mix the gases before they strike the heating surface.

Fig. 2 illustrates a full-extension, down-draft setting for a water-tube boiler, in which an arch 5 ft. 6 in. long has been sprung back of the bridge-wall, with sufficient throat area past the arch to allow the gases to escape. The bridge-wall action is good, as the radiation from it has the effect of maintaining the temperature of the gases, and as the gases impinge against it in changing their direction, combustion is aided materially. In new down-draft furnaces and water-tube boilers, the latter always should be horizontally baffled and the furnace have deflection arches.

Fig. 3 shows another down-draft installation set full extension. As shown in the drawing, the construction

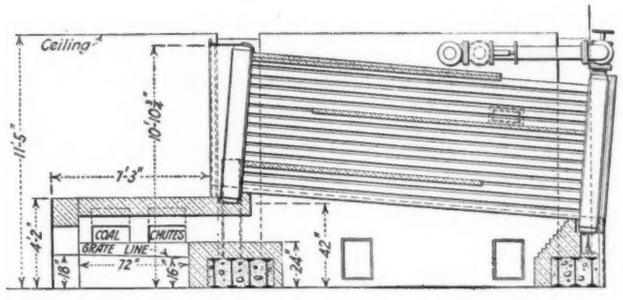


FIG. 4. A 375-HP. DRUMLESS EDGE MOOR BOILER AND BURKE FURNACES SET IN HEADROOM OF 11 FT. 5 IN.

calls for a high-temperature zone over the bridge-wall and a deflection arch in three spans before the gases pass to the heating surface. These compromise settings must be taken for what they are worth in cleaning up existing plants rather than as satisfactory settings for new installations.

Fig. 4 illustrates an interesting case where a 375-hp. drumless Edge Moor boiler served by Burke furnaces was set in a headroom of 11 ft. 5 in. Here are conditions which are sometimes met when putting a new power plant in an old building. In this case the building stood on a floating foundation, consisting of a mass of concrete and railroad iron in which it was impossible to do any excavating. At the same time it was impossible to raise the ceiling as it would then interfere with valuable floor space in the office building above. Therefore, the boiler installation had to be sacrificed and the design shown herewith was adopted. One of its features was the location of the safety valves. The headroom was so restricted that they had to be set, one on the side of the header, with a U-tube connection into the steam space of the boiler. Notwithstanding the conditions, these settings have been running successfully for years without smoke and without any unusual difficulty with the boilers.

Waste Hot Water Heats Feed-Water

By F. B. Hays

The writer recently designed a chemical plant in which several novel engineering features were embodied. The most interesting, from a power standpoint, was the manner in which the boiler feed water was heated.

The plant contained a battery of three boilers, two being in service while the third remained idle for clean-

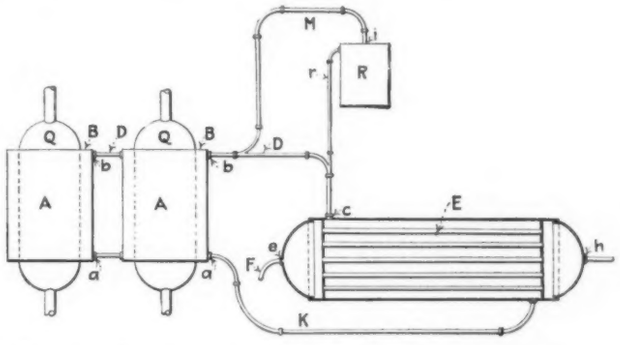


FIG. 1. JACKET OF CHEMICAL TANKS AS FEEDWATER HEATERS

ing or emergency. The steam was used directly in reduction tanks, becoming a part of the final chemical composition manufactured. This left no exhaust steam for heating feed water, and as there was much waste heat in the plant, it was not considered advisable to use live steam. Cooling water used to reduce the temperature and prevent explosions in the chemical reduction tanks was going to waste. After a careful study of the operating conditions in the reduction tanks it was decided that the cooling water could be used for heating the boiler feed water, and the latter kept at a fairly even temperature provided a suitable heater was installed. The heater shown in Fig. 1 was finally chosen.

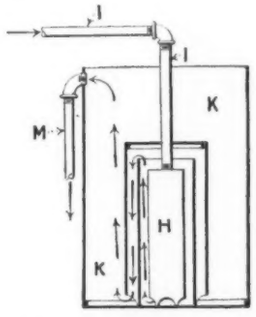


FIG. 2. SECTION OF OVERFLOW BOX

The general arrangement of the whole system is shown in Fig. 1, in which are the reduction tanks *A*, where temperatures ranging from 70 to 600 deg. F. are produced by the chemical reactions; the water jackets *B* surround the cookers *Q* of the reduction tanks, into which the cooling water enters at *a*, and, becoming hot, flows out at *b* and through the pipe *D* into the boiler feed-water heater *E* at *c*. The boiler feed water (cold) passes through the pipe *F* and enters the heater at *e*. It leaves the heater at *h* for the boiler-feed pump, after it has become heated by the cooling water from the reduction tanks, and has in turn cooled this cooling water. The cooling water returns to the reduction tanks by the pipe *K*. The circulation of the cooling water is by gravity.

Due to the high temperature frequently produced in the cookers, provision had to be made to take care of steaming of the cooling water. This was done by means of an overflow pipe *M*, which discharged into the radiator *R* at *i*, from which it flowed into the heater *E* at *r*.

The construction of this radiator is shown in Fig. 2, where *I* is the pipe by which the water and steam from the reduction tanks enter the radiator, *H* the tubes where the steam is condensed, *K* the water tank of the radiator, and *M* the overflow pipe from the water tank to the feed-water heater. The object of this type of radiator was not only to condense and utilize the steam from the cooling system, but also to keep hot water flowing into the feed-water heater at all times. Since the temperature in the cookers varies as much as 400 deg. in an hour, it will be readily seen why such a device is necessary. On account of this same variation in temperature, the cubic contents of the feed-water heater had to be far in excess of that normally used or required in proportion to the area of its heating tubes, so that it would act as a large heat reservoir, which would not be readily affected by sudden changes of temperature of the feed-water passing through the cookers.

Will Quizz, Jr.

SYNOPSIS—Will Quizz asks about the shape of steam nozzles and is surprised to hear that an enlarging nozzle of the correct proportions will cause an increased velocity of the steam jet.

"Chief, what is the reason for the shape of the nozzles in our turbines? Instead of pointing the little end of the nozzle toward the rotor the big end points there."

"This is done, Will, to give a greater velocity to the steam. Fig. 1 shows that the velocity of steam issuing from a straight nozzle is almost constant for all pressures."

"How can an enlarging nozzle increase the velocity?"

"It is like this, Will; back in 1883 Dr. DeLaval made the first use of such a steam turbine by applying it to milk and cream separators. After experimenting, he concluded that the successful motor of this type should utilize the velocity of the steam rather than its direct action by pressure. His first step, therefore, was to convert the force in the steam into kinetic energy and obtain the highest possible velocity for the steam. He conducted

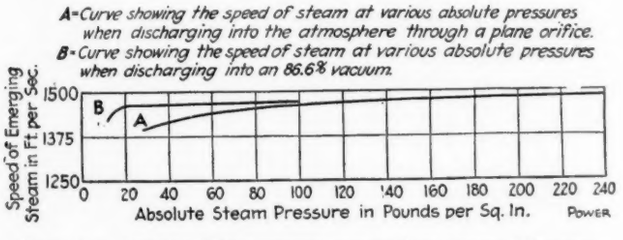

A-Curve showing the speed of steam at various absolute pressures when discharging into the atmosphere through a plane orifice.
B-Curve showing the speed of steam at various absolute pressures when discharging into an 86.6% vacuum.
Speed of Emerging Steam in Ft. per Sec.
1500
1375
1250
B
A
0 20 40 60 80 100 120 140 160 180 200 220 240
Absolute Steam Pressure in Pounds per Sq. In.
POWER

FIG. 1. STEAM VELOCITIES WITH STRAIGHT NOZZLE

a number of experiments and established the shape of the nozzle which would produce this effect.

"Probably the easiest way to describe this would be by comparing the steam in the boiler under pressure with a lot of toy balloons in a closed vessel under sufficient air pressure, so that each one, instead of being some four inches in diameter under atmospheric pressure, would be compressed to perhaps one inch.

"Suppose then these balloons were allowed to escape through an opening just large enough for one to pass through at a time and into the nozzle of the shape shown. Immediately after passing through the small end they would begin to expand by reason of the reduced external pressure, but if the nozzle did not enlarge in proportion to this expansion it would elongate and increase its velocity as it expanded.

"This elongation necessarily would have to take place in the direction of the flow because the others, following under pressure, would urge it forward and prevent any rearward elongation or even any retarding of the outward flow, so it will be seen that the velocity must increase in order to allow for the expansion. Fig. 2 shows the increasing velocity of the steam issuing from a properly designed diverging nozzle.

"Referring to your steam tables again, Will, you will see that the specific volume of one pound of steam at 465 lb. pressure is one cubic foot. At lower pressures the

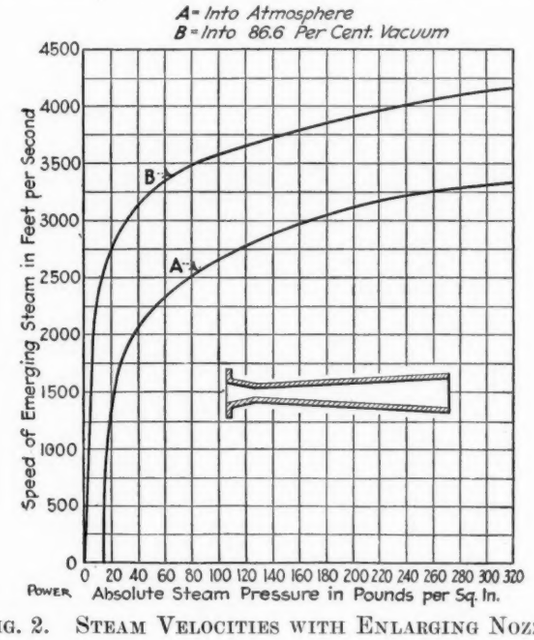


FIG. 2. STEAM VELOCITIES WITH ENLARGING NOZZLE

volume is greater, and at atmospheric pressure one pound occupies about 27 cu.ft. (or 27 times the original volume for a given weight of steam). As the pressure decreases below that of the atmosphere the volume increases rapidly, so that at one pound absolute pressure it occupies 333 cu.ft.

"The shape of the nozzle—that is, its rate of enlargement—must be proportional to the initial pressure and terminal pressure against which the steam flows, but the more extreme these two pressures are, the more abruptly the nozzle may enlarge. Therefore, nozzles are of different proportions or designs for different boiler pressures and the amount of back pressure or degree of vacuum into which the steam is discharging. With a given area of throat or small section the area of any section beyond is directly proportional to the specific volume and to the dryness of the steam, and inversely proportional to the velocity."

Editorials

Value of the Extra Man

How many manufacturers believe that it would pay to employ an extra man in the engine room, so that the chief engineer would have more time to devote to the boiler room and see that the maximum fuel economy is maintained?

Fuel is the main expense in all power plants, and although many consider it, more ignore it.

In one plant for instance, the owner will not be bothered about the coal, but insists on purchasing the engine and cylinder oil himself. The fuel item would run into thousands of dollars annually; the oil would cost a few hundred.

As pointed out in a first-page cartoon some time ago, the switchboard of most electrical plants carries all the necessary recording and indicating instruments, so that the attendant can keep a record of the output in electrical energy. But out in the boiler room there are only the old safety valve, water glass and pressure gage, with nothing to indicate the performance of the boiler. The bills for coal and supplies come to the office and, although protest may be made against their size, nothing is done to help the engineer reduce them.

In other plants some attempts may have been made to obtain efficient operating results, and perhaps instruments for ascertaining the percentage of CO_2 in the furnace gases have been provided, together with draft gages, steam-flow meters, etc., but if no attention is given them, they might just as well be cut out for all the good they may do.

Pointing out defects is useless, unless measures are taken to remedy them. If help is so limited that there is not time for some one in authority to find the source of loss and to see that matters are changed for the better, then good American dollars are going to waste, because nobody is held responsible for the loss.

Engineers well know the situation, and there are many of them who are striving, even against adverse conditions, to operate their plants economically. There are others who are indifferent, because the men higher up do not do their part in preventing losses.

With so many plant owners and managers lax in this regard, it is refreshing to know that one manufacturing company (see the article, p. 38) realizes the greatest opportunity to save is in the boiler room, and that an overworked engineer cannot give proper attention to securing economical operation. For this reason an extra man is employed in the engine room so that the engineer may give time to getting all possible out of every pound of coal consumed in the boiler furnaces. Moreover, instruments are provided to show the operating conditions, and are so arranged that any one of the boilers can be checked by the instruments.

How many power plant owners believe that if the chief engineer is given the opportunity he can more than save a man's wages by properly managing the boiler room? Why not give him a chance and find out?

Getting New Business

Small electric-light plants may note with profit the accomplishment of the Springfield (Missouri) Gas & Electric Co., which has added two hundred new residence customers to its circuits in sixty days, with no line or transformer expense.

This increase in new business is largely accounted for by the fact that the company offered to put in a few outlets, and did not insist on wiring the houses complete before putting in the service. This naturally appealed not only to owners, but to renters of even small houses. With the service once in, the convenience was apparent, and additional outlets were added here and there, so that what did not represent an attractive connected load at first has gradually become a profitable one.

A small station cannot hope to obtain the same number of new connected houses in the same period as did the Springfield company, but what is to prevent the idea from being worked out on a smaller scale in smaller cities and towns? It would appear to be worth trying.

Water-Power Legislation

Hearings on the Ferris water-power bill, before the Senate Committee on Public Lands, developed that its passage in the Senate will be opposed on two grounds. A small clique of Western senators will oppose the measure because they want the dam sites in the public domain deeded over to the states without condition. The influence of large hydroelectric promoters and operators will be exerted against it because they want power sites given to the companies in perpetuity. The bill as it passed the House proposes that power sites on the government lands shall be leased for not more than fifty years, and that the property shall revert to the government at the end of that period.

It was brought out at the hearings that Canada, Norway, Sweden and other countries where there are large water powers have secured their development under very much the same plan as that now urged by the administration and embodied in the Ferris bill.

Upon the action of the Senate on this bill and on the Adamson dam bill, both of which have passed the House and are awaiting senatorial action, depends whether there shall be any extensive development of water powers in the United States in the near future. Under present laws, such development is almost impossible. So far as Western water powers are concerned, they are practically all in one of two classes: either held in private ownership by large corporations which form what Gifford Pinchot and others declare to be a "water-power trust," or they are within the public domain, under the ownership and control of the Federal government. In the East and South, there are also large potential water powers on navigable streams which can be utilized only by permission of Congress.

The War Department claims jurisdiction over navigable streams, on the ground that any obstruction of these affects navigation, which is under Federal control. In the public domain, there has been some granting of permits for water-power development along streams in forest reserves, which are under the control of the Department of Agriculture. So far as power sites in the public domain outside of the forest reserves are concerned, however, there is no law permitting any leasing or permits. They must either be withheld entirely from use, or given away as farm lands to anybody who asks for them. Judge Finney, of the Interior Department, told at the hearings of one power site acquired by a power company from the government at one dollar and twenty-five cents an acre as agricultural land, and capitalized at twenty-six million dollars by the corporation which secured it.

These water-power hearings have brought out clearly the story of how the water powers of the West are monopolized, and the ramifications of the big power corporations. They have also served to point out forcibly the difficulty that exists in drawing the line between state and Federal authority in the control and regulation of these matters. All the water in the streams is owned by the states. The courts have said that more or less clearly. So far as its use is concerned, however, the Federal government has control over everything affecting navigation, and the courts have not decided just how far back toward the source of the stream that extends.

In the proposed general dam bill, the power claimed by Congress is drawn entirely from its right to control navigation. Even if a corporation owns a dam site, and the state in which the site is located has granted a right to the use of the waters of the stream, the dam-site owner cannot build his dam without the consent of the Federal government, on the theory that the dam might interfere with navigation. In the past, permission for the building of dams and power plants along such streams has been made the subject of special acts of Congress, it being necessary for a company to get a specific act through Congress to enable any dam to be built. In the pending bill, it is proposed to make a general law governing the granting of such permission, and allow the Secretary of War and the Secretary of the Interior, under certain restrictions and conditions, to grant such permits.

The Adamson bill would open to use, under regulation, the unused water powers and power sites in the East, South and Middle West. The Ferris bill deals with the water powers in the public domain, which is almost wholly in the far West. The latter, in fact, makes no proposal for regulating the use of water powers, but deals wholly with power sites. However much power there may be in a stream or a waterfall, it is useless unless there is a place to build a plant for its development. Where these dam sites and power-plant sites are on land owned by the government, the Ferris bill proposes that the government shall lease the sites on such terms as will enable the government to forever control the development of power at that point.

In an effort to propitiate the "states' righters," the Ferris bill proposes that where electricity is used in the same state in which it is generated under a Federal lease, the operations, rates, etc., shall be subject to state regulation, where there is a state utility commission. Where there is no state regulation, the government is to do the regulating. Where power is generated in one state and carried into another state for use, that used in the state where it is generated is to be under state regulation and that in the other state to be under Federal regulation. Where the company does an interstate business, however, not only the current which is sent across the state line, but also the entire assets and affairs of the company generating the power will come under Federal control and regulation. In actual operation, it seems probable that the effect of the proposition, if the bill becomes a law, will be to have both Federal and state regulation over the same enterprises.

The bill proposes that the rental charged by the government for the power site shall be decreased in proportion as the operating company decreases the price to consumers for light and power. Senator Smoot, of Utah, who opposes the measure, ridiculed this proposal in the committee hearings, on the ground that it would be more profitable to the companies to pay the higher taxes and exact the higher rates.

The money derived from leases of power sites is to be placed in the reclamation fund, and after it has once been used for reclamation projects and repaid to the government by the water-users on these projects, it is then to be equally divided between the states and the government.

Encouragement

How many chief engineers encourage their men by expressing satisfaction when work has been well done? How many comment favorably upon the personal appearance of their assistants? What would be the result if appreciation were expressed? Nothing will encourage a man to do his best so much as the knowledge that his work has received recognition. Nothing will cause a man to become disgruntled so much as an attitude of nonappreciation on the part of the chief.

An assistant engineer need not fear being classed as a "dude" because he prefers to go about his work with clean clothes. If he does not keep himself clean and neat, the chances are that he will be slovenly about his work. Some engineers have the appearance of coal passers, and their plant presents the appearance of having seen better days. No self-respecting man can be content to work in a dirty engine room where it is impossible to keep himself in a half-way presentable appearance. Encourage men to do better work, to keep the plant clean, and their own improved appearance will follow.

If a man thinks well of himself, and he will in cleanly surroundings, he will think well of his chief and of the company that employs him.

Not a single passenger out of the 188,411,876 carried in 1914 on all of the 26,198 miles of track of the entire Pennsylvania R.R. system was killed in a train accident.

This looks to us like real forethought and true business acumen on the part of the Pennsylvania R.R. It realizes that the more passengers it kills the less it will have to carry, so it tries not to kill any. Last year it was successful and had a perfect score—no misses.

Indexes to POWER are furnished free to all who request them. That for the last half of 1914 will soon be ready. A simple request, addressed to the Subscription Department, POWER, will bring one.

Correspondence

Stresses in Convex Heads

In the Dec. 8 issue there is a discussion of my contribution to the issue of July 7 concerning stresses in convex heads. The first remark by Mr. Vander Eb to the effect that the results of my analysis are at variance with opinions previously expressed depends on the point of view. When an abstract analysis of a statical or physical problem is undertaken, all opinions, even those of the mathematician, are irrelevant. The matters pertinent to the analysis consist of, first, the premises upon which the analysis is based; second, the propriety of the mathematical processes that are employed, and, third, the specification of the consequences of the analysis. I fail to see anything peculiar in the fact that an attempted analysis of a problem in statics leads to results at variance with current opinion since current opinion, heretofore, has been at variance with the facts concerning the safety of convex heads.

Concerning the more direct discussion of the analysis by Mr. Vander Eb it is fair to examine the premises upon which my analysis is based for the errors which are said to exist. He asserts that I have neglected the deflection of the dished part of the head "by simply assuming that a purely spherical tension at the circumference is all one need to expect." If anything new in the way of theory of stress in spherical shells, or in portions of them, can be offered, there may be sufficient evidence to enforce the abandonment of the respect for such writers as Rankine, Church, Merriman and Cotterill.

There is nothing more explicit than the statement of Rankine ("Applied Mechanics," p. 290), viz., "hence the whole force to be resisted by the tenacity of the shell is," etc. The statement admits of no shearing stresses or any stress in the spherical shell other than a simple tensile stress. The presence of shearing stresses would cause local deflection from the spherical surface and their absence precludes "deflection."

Referring to Fig. 2, by Mr. Vander Eb (which is substantially the same as Fig. 4 of the July publication), it will be seen that the element of the flange fillet is completely supported by the system of forces as specified. Some of these forces constitute "reactions" on the part of adjoining material which, if properly accounted for, dispose of further consideration of such extraneous material in the analysis. I have shown the justification for the acceptance of the force T as a simple tension unaccompanied by shear stresses on the face DC of the element. If there is any bending of the material of the plate at the section AB, there is at least a "stress couple" and possibly shearing stresses. By the selection of the origin of reference at O', at the middle of the plane AB, all effects of these shearing forces from the moment equations are eliminated.

A little reflection and reconsideration of the detailed analysis in the article of July 7 will show that Mr. Vander Eb is wrong in asserting that the element of the flange fillet is considered as a beam with "free" ends. The remainder of this paragraph in the Dec. 8 article is somewhat questionable in the attempted substitution of impressions, however plausible they may appear, for the logic and conclusions of a statical moment equation that is either right or wrong. In the interest of engineering progress, the elimination of errors should be the ambition of all concerned. I cannot see the justification for the introduction of the forces on the sides of the element (Fig. 3 of the July 7 article) for reasons explained originally.

Mr. Vander Eb overlooks the fact that the analysis contemplates attachment of the convex head to a rigid cylindrical shell as "a yield of the structure at the flange connections would seriously complicate the stress-strain relations." Furthermore, a yield at this point would be incapable of analysis with the present limitation of the theory of statically indeterminate structures.

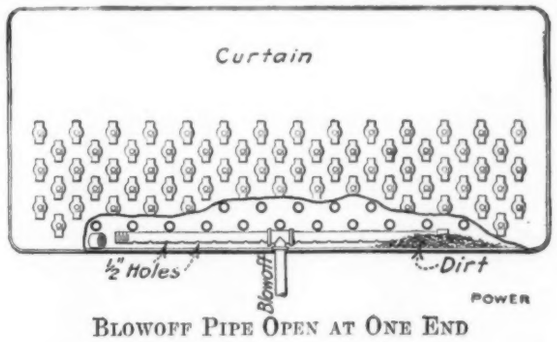
With much of the remaining discussion I have but little reason to dissent. One criticism of my article, and all similar articles, was overlooked which I will undertake to supply. The analysis may be wrong because it has assumed a homogeneous molecular state of the material in the plate after it has been heated, flanged, cooled and forced into shape and place by any practicable flanging process. There is no means of estimating the magnitude of the initial strains in a dished head, and particularly in the region of the flange fillet. These may be, and in certain cases actually have been, so severe that the heads cracked while they were being riveted to the shell. At the risk of a small increase in cost of boiler construction, a flanged head could be subjected to suitable heat treatment or at least proper annealing when, if ever, the plate may be assumed to be free from internal strain.

F. G. Gasche.

South Chicago, Ill.

Side Tubes Blistered

Why the tubes blistered on one side of the bottom row in one of our water-tube boilers was not found out until the mud drum was opened. As shown in the illustration, the blowoff was connected to a tee inside of the mud drum, into which were screwed two short lengths of pipe supported about 2 in. from the bottom of the drum and having ½-in. holes drilled in the lower sides and the ends capped.



Blowoff Pipe Open at One End

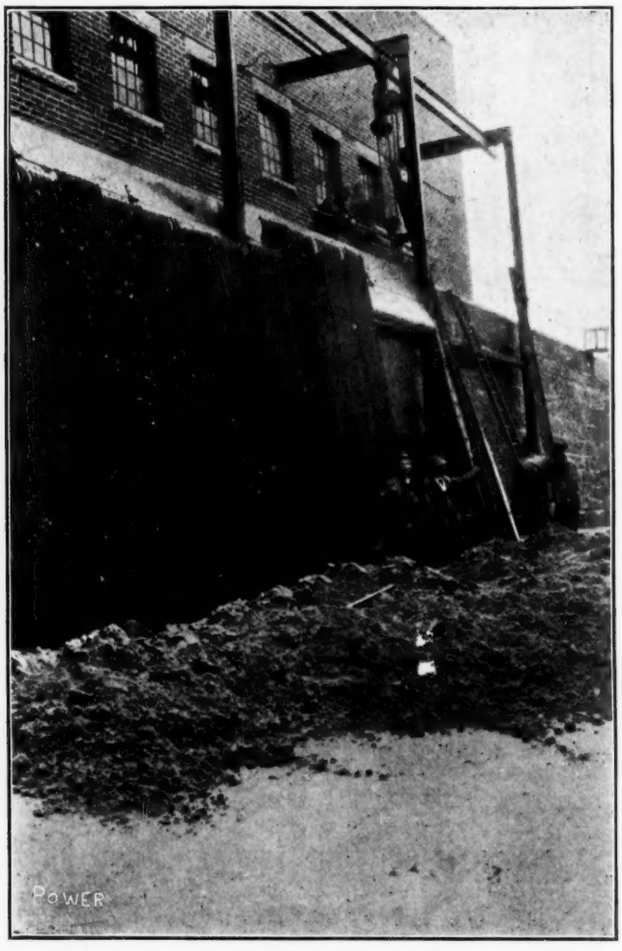
One of the caps had worked off and consequently all of the drainage or blow was from that end. The sediment gradually accumulating at the other end had stopped the circulation in the tubes and allowed them to become overheated.

EDWARD T. BINNS.

Philadelphia, Penn.

High-Pressure Water for Cleaning

New trash racks were to be placed in front of the water-wheel chambers at the hydro-electric plant in which the writer is stationed. On letting the water out of the head



DIRT AT THE INTAKE SCREENS

race, which is about 16 ft. to the concrete footing on which the bottom of the racks were to rest, the footing was found to be covered with sand to a depth of 4 or 5 ft. Much of this sand was removed by shoveling, but as there was some water dammed up behind this bank, which could be drained out, the sand was washed in almost as fast as it could be shoveled away.

In the plant we have mains carrying water at a pressure of about seventy pounds. The use of this water to do the work was suggested, and the plan was carried out with success. A line of 3-in. pipe was coupled to the water main, and to this pipe a 3-in. suction hose was connected. A nozzle was needed and as none was at hand, we proceeded to make one out of a short piece of 3-in. pipe about 3 ft. long and threaded at one end. The other end was heated in a forge and the edges flattened, leaving an outlet 1½ in. diameter and flared back to the diameter of the pipe. This nozzle was coupled to the hose and the full pressure turned on. The sand was thoroughly stirred and in a short while most of it was carried off. The rest was kept constantly stirred by the water, and the racks, section by section, quickly dropped into place. The illustration shows the head race.

J. M. PURCELL.

Richmond, Va.

Starting Small Motor

We have a small direct-current, shunt-wound motor that had been used satisfactorily for driving a bottle-washer by throwing directly across the line in starting. When it was belted to a jigsaw, where there was more friction, it had to be helped in starting. Believing that the heavy starting current might have so weakened the shunt field as to reduce the torque, the writer placed a bank of lamps in series with the armature, upon which the motor started easily, although the running speed was reduced somewhat.

It appears that above a certain point an excessive armature current in a shunt motor reduces the torque instead of increasing it.

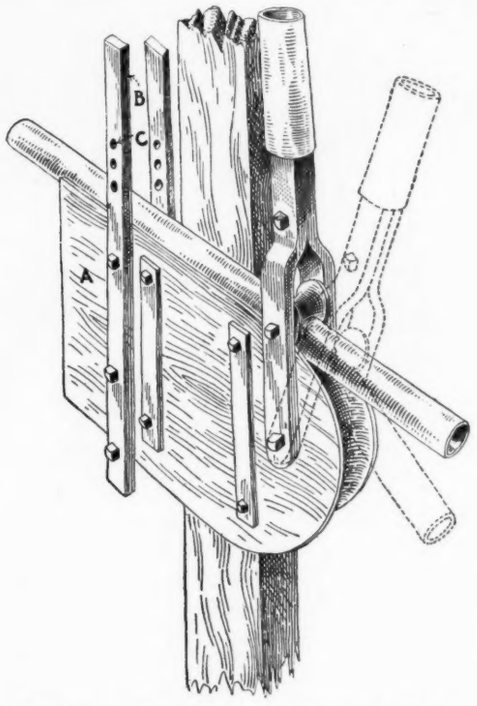
WALTER S. GRISCOM.

Buck Hill Falls, Penn.

Pipe Bender

In a plant where it was necessary to bend pipe of various sizes from 1 to 2½ in., the simple pipe bender shown did good work.

A 2-in. hardwood plank 18 in. long by 12 in. wide,



PIPE BENDING FORM CLAMPED ON POST

rounded off at one end to a 6-in. radius, was fastened to a post in the shop. Two pieces of 1½x½-in. flat steel *B*, one on each side, and extending 5 in. above the top of *A*,

had a number of ¾-in. holes for a pin to hold the various sizes of pipe. On the rounded end was fastened a swinging arm or lever and roller held in place by a bolt through two pieces of 1½x½-in. flat steel, and pipe extensions of different lengths furnished the required leverage to bend the various sizes of pipe.

The method of operating is to hold one end of the pipe to be bent in the space between *A* and a pin in *C*, and bring the roller to bear slightly, then draw the pipe forward an inch or two and repeat the operation until the required bend to any number of degrees is completed. This apparatus is inexpensive, easy to construct and is convenient for making offsets and lateral bends.

W. E. Chandler.

Quinebaug, Conn.

Gaskets for Plugs of Compressor Valves

In the Nov. 10 issue, Mr. Herr asks for information about material for gaskets for plugs in ammonia-valve bonnets.

There are four kinds of valve bonnets for ammonia compressors. The most common form is such as is found on the Linde type of machine. It is held in place by studs or capscrews and the gasket fits into a recess so formed that the male part of the bonnet holds the valve cage down to its seat in the casting. Almost any ordinary gasket, rubber, lead or other material, will make a tight and lasting joint. One-sixteenth-inch lead or rubber sheet packing is much used, but if the joint is troublesome the use of one-sixteenth-inch rubber packing of nearly pure gum is advisable.

Before inserting the gasket, it should be noticed that the top of the valve cage projects about one-sixty-fourth of an inch beyond the surrounding surface. If the cage has been ground into the seat and the top is below this surface, an extra gasket must be used which fits the valve cage only and acts as an extension to it, allowing the bonnet to hold the cage tightly in place. Neglect of this will allow leakage between the head or cylinder casting and the cage, proving no better than a leaking valve. This style of bonnet is found on compressors of many makers.

There is a bonnet where the valve cage is set in the compressor head and held to its seat by a ring or nut; the bonnet is screwed into the head outside the ring. Rubber gaskets are supplied by the builders of the machine and never give any trouble when inserted properly.

Then we have the style of bonnets used on the old Boyle and Pennsylvania Iron Works compressors. Here a yoke is used, the studs being screwed into the compressor head and an iron strap reaching from one stud to the other, with the valve bonnet between the two studs. A setscrew passes through the strap and when screwed down forces the bonnet to its seat. The same material can be used for gaskets as in the Linde type, but pure gum is preferable as it is soft and does not require such pressure as does lead to make a tight joint.

There is another type where the valve cages are put in from the cylinder side of the compressor head and the bonnet screws onto the threads on the outside of the upper end of the valve cage. The cage is kept from turning by a dowel pin. Sheet lead one-sixteenth-inch thick is the proper thing for these gaskets as the turning effect of the bonnet might tear or misplace a rubber one. If the joint is a particularly troublesome one, put a gasket of one-thirty-second-inch pure gum beneath the lead. There is no reason then why the joint should not be tight unless there is some defect in the casting or the valve cage is too long, the top of it striking the inside of the bonnet before the gasket is pressed tight.

The temperature of an ammonia compressor should never be so high that it will melt lead. Use plenty of water over the jacket or send the suction vapor to the compressor in a slightly saturated condition. Properly cut and inserted gaskets of either one-sixteenth-inch sheet lead or of good sheet rubber will keep these from leaking unless something is mechanically wrong.

The nuts, capscrews or screwed bonnets of compressor valves must be frequently tried with a wrench as the changes of temperature to which they are subjected will cause them to become loose.

A. G. Solomon.

Chicago, Ill

Cylinder-Head Packing

A good gasket, which will hold where rubber will not, may be made of copper wire if the surfaces are reasonably smooth and true. The copper should be annealed by heating it red hot, then dipping it into water once or twice, or until soft enough. Gaskets may be made of any size suitable to the work from ⅛ in. to $^1/_{64}$ in. After the wire has been annealed, draw it around the cylinder head and twist it a couple of times, and then flatten the twist a little thinner than the wire.

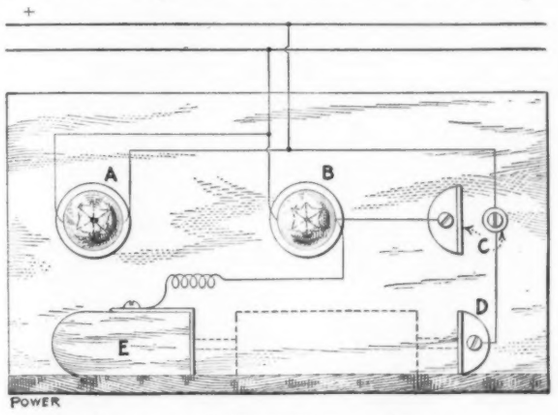
Either solder the ends or wind candle wicking around the joint. Put the cylinder head on and draw up evenly on all the bolts, and then hammer a little on the head over the wire to flatten it. Next, take up snugly on the bolts. Soldering the gasket to the head will keep it in one position all the time and will be convenient if the head is to be removed frequently.

John P. Kolar.

Ithaca, N. Y.

Lamp and Fuse Tester

I have a simple and convenient tester for lamps and fuses, the wiring plan of which is shown in the illustration. The metal part of the socket *A* is slit and opened



Lamp- and Fuse-Testing Board

so that the lamp need not be screwed in, but simply pressed in.

B is a lamp screwed in permanently as an indicator

in testing plug fuses at *C* by placing the end on the bottom connection and the side in contact with the metal side. If the fuse is good the lamp at *B* will light up.

Contacts *D* and *E* are for testing cartridge fuses. The dotted line shows a fuse in place with the sliding, metal-bound block *E* pressed against one end. The outfit can be mounted on a marble slab or asbestos-covered board to suit one's fancy.

JAMES G. SHERIDAN.

Brooklyn, N. Y.

Pottery Clay in Fireclay Service

In the Dec. 15 issue of POWER appeared an article on the use of cement for furnace lining as practiced by the Robert Gair Co., Brooklyn, N. Y. This called to mind an experience I once had in repairing the setting of a 250-hp. water-tube boiler in a remote part of the West Indies.

One day we found ourselves short of fireclay, due to a delay in shipment, and it was necessary to repair the boiler setting at once, and replace practically all the firebrick around the door arches, etc. We tried to buy or borrow enough fireclay to do the work but everyone seemed to be short at the same time.

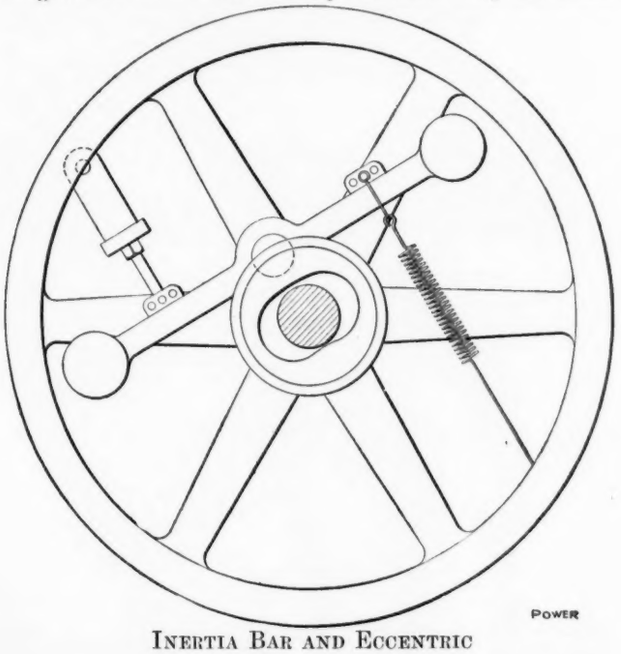
In the neighborhood was a small pottery plant, so as a last resort we decided to see how good a fireclay this unburned pottery clay would make. We were surprised to find that it lasted longer than the brick and fireclay around it.

F. E. WOOD.

Whitinsville, Mass.

Trouble with Inertia Governor

An inertia governor of the type shown gave considerable trouble on account of its sluggish action. After running for an hour or two the speed would drop for a moment, then pick up again and be all right for a while. The eccentric ran a little warm after the engine had been off for repairs and the eccentric straps were tightened up. The added friction, however, retarded the governor, causing earlier cutoff and reduced speed. When a paper liner was put in the trouble stopped.



INERTIA BAR AND ECCENTRIC

At another time the same engine ran unsteadily. Changing the adjusting screw in the oil bypass of the dashpot helped some, and when a lighter grade of oil was substituted, the engine governed satisfactorily.

Sometimes the roller bearing, which has $\frac{5}{32}$-in. rollers, wears slots in both the bushing and the pin. This retards the action of the governor, but a new set of rollers, a pin and bushing will make it entirely new.

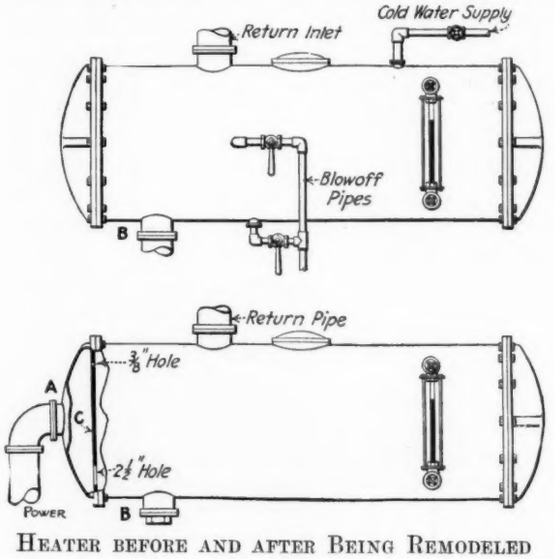
Governors of this type must work very freely, otherwise they cause a great deal of trouble.

J. C. HAWKINS.

Hyattsville, Md.

Oil from Heater Got into Boiler

The top diagram shows a combined feed-water heater. In our plant the returns from the heating system and the exhaust from other pumps and engines return to this heater. There is no oil separator in the exhaust line from the pump, consequently oil gets into the heater.



HEATER BEFORE AND AFTER BEING REMODELED

As originally installed, the apparatus gave no trouble so long as the man in charge was careful to use the blowoff cocks to rid the heater of oil. One night the fireman pumped the heater dry, not noticing the lowering water level until too late. There was considerable oil in the heater at the time and it got into the boiler.

To avoid further trouble, the suction line to the heater was made to enter the tank in the center of the head as shown at *A*, while the original suction line *B* at the bottom was plugged. Between the head and shell there was placed a sheet-iron plate *C*, ⅛ in. thick. At the top a ⅜-in. hole was bored and at the bottom a 2½-in. opening was allowed in the plate, the water going out of this hole on its way to the pump. The function of the ⅜-in. hole is to prevent the pump from siphoning the water in the heater over into the suction line. With this arrangement we are never troubled by oil getting into the boiler.

H. G. GIBSON.

Washington, D. C.

Former Engineer of La Salle Hotel Defends His Administration

The attention of readers of POWER is called to the article appearing in the Nov. 3 issue of that paper, page 628, in which statements were made that the power plant in the Hotel La Salle, Chicago, Ill., was not operated efficiently during the years 1910 and 1911. The following facts and figures are in contradiction to these statements.

The Hotel La Salle was opened in 1909 under strike conditions of the mechanical trades, there being thousands of dollars' worth of unfinished work which had to be finished after the house was opened. Also revision of plans and certain changes necessary to be made to suit conditions made an enormous amount of extra work to be completed by the engineering department and necessarily created a large expense for labor and material, which was chargeable to the engineering department, but should not have been charged as an item of operation.

It was required by the management at that time that the house be thoroughly ventilated at all times, which required all ventilating fans to be operated constantly at their scheduled speed for furnishing the quantities of air required. Voluntary information handed the writer from a person who served in the mechanical department under Mr. Bird, present chief engineer, states that replacing the 16-cp., 60-watt lamps through the house with 25-watt tungstens shows a saving of 437 kw. on lighting load alone. This change was often suggested by the former engineer, but was not entertained by the management. He also states that over 100 hp. in motors were closed down, the greater part being on ventilation. Relative to these items, it is beyond contradiction that there is any credit or discredit due either engineer, as the same saving would have been effected had the company seen fit to make such changes in service before.

It is not the purpose of this article to reflect on the present management of the plant, but simply to submit to your readers such facts and figures as will contradict the misleading statements reflecting on the former management.

The steam traps mentioned in the article of Nov. 3 were one of the best known makes, which gave excellent satisfaction, and owing to the complete system of piping there were but very few traps required for the handling of all condensation from the entire house, each trap being fitted with test valves below the valve in the main discharge pipe in order to test the traps for leakage. Each trap was tested daily by closing off the discharge valve and opening the test valve, allowing the trap to discharge into the atmosphere, to determine if the trap was working properly, it seldom being necessary to renew seats or valves. It is therefore flatly contradicted that there was any loss of steam from this source.

Also during the time the hotel plant was operated by the chief engineer previous to Mr. Bird's time, vacuum cleaners were in constant use. They were three in number, and a great deal of the time during the day the three were in use at once. Probably POWER has not been informed that these are now used but very little.

Another item which should have reduced the operating expenses of the plant was the discontinuing of several hundred lights around the banquet-hall windows and 19th floor. During the previous engineer's time at the La Salle Hotel, these lights were required to burn from lighting time in the evening until 1 a.m. It can readily be seen that by discontinuing these lights the load would be greatly reduced, which also has no reflection upon the engineer.

There were always constant changes being made in rooms, kitchens and other portions of the house for the first two years which required an extra force of men, all of which came under the chief engineer's charge and were chargeable to his department, although not an item of plant operation.

We wish to state further that during the coal shortage in the winter of 1910, the hotel company, not being under contract with any coal concern, made it necessary to burn whatever coal was on the market, and the greater part of the time coal was used that ran 20 per cent. ash, making it necessary to run from one to two boilers more than should have been run if good coal could have been obtained, to say nothing of the high prices they were compelled to pay. No steam was allowed to go to waste at any time, as a daily record was kept of the amount of water evaporated and the coal burned. These records were absolutely correct, as the meter was inspected once each month by an expert from the Worthington Meter Co., and if any repairs were found necessary, they were made by him. Evaporation was kept up to the highest possible point at all times as the test made by a prominent engineering company of Chicago will show.

In reference to the operation of the different electrical units, it was found to be impossible to change their schedule at that time as the official test also shows they were operated at their most economical point. No steam ever escaped from exhaust pipes in winter except in very mild weather or perhaps for a short interval at lighting time in the evening, while engines were being changed. All rooms were supplied with artificially cooled air in the summer months that were designated to receive it.

The cutting off of this service would also reduce the operating cost, but with no credit to the present engineer or discredit to the former, as the entire plant might be shut down and have no expense at all. It is a well known fact that during the former chief engineer's time at the hotel, the power plant was a credit to a house of its kind. It was light, clean, well kept and with smooth running machinery. Today it will speak for itself. It is a very easy matter to cut down expense at the sacrifice of the plant.

Such furnace changes as were made speak for nothing unless a higher CO_2 or a higher evaporation can be obtained, which the previous article has failed to show, but which is shown by the test made by the engineering company to be above the average evaporation for the best equipped plants. It is plain to see, according to the article printed in POWER of Nov. 3, that no tests of any kind were made by Mr. Bird to determine the amount of work done. The article merely states that "eight pounds of water were evaporated per pound of coal," but for all the figures shown it might be four or it might be fifteen, but not so in this article, as the facts and figures are here in detail and are signed by a company recognized as high authority on scientific tests. Note the evaporation, also cost of generating current, and then compare

with the article printed on pages 629 and 630 in POWER, Nov. 3 issue.

It is also a fact that the man who operated the hotel plant previous to Mr. Bird is a person holding a very responsible position with a large and well established firm, he having charge of several large plants, all of which generate their own power and are equipped with high-class machinery, which plants employ a very large force of engineers and mechanics.

No mention was made in the Nov. 3 issue of POWER of the new elevator pump being installed in the La Salle Hotel since Mr. Bird's time, which cost several thousand dollars and from an engineer's standpoint being wholly unnecessary, as the original pumps never failed to handle the nine hydraulic cars all in service at once at high speed, with always one pump in reserve, and at no time were any of the cars shut down except for repairs and then only after 12 o'clock midnight, as it required the six passenger cars to handle the enormous number of guests in the hotel at that time. Also the installation of a new hot-water heater, from the same point of view, would be considered unnecessary, as the heater originally installed never failed to furnish sufficient quantities of hot water when the house was filled to its capacity.

Following are some of the important and interesting facts of the tests made by the aforesaid engineering company, a copy of which was given the writer by the hotel management at that time:

Relative to purchasing electrical power: If a lower rate than 1.2c. per kw.-hr. can be obtained from parties selling power, it is recommended electrical energy be purchased during the summer period, viz., May 1 to Oct. 31. The requirements for these six months are approximately 1,540,000 kw.-hr. The average cost to generate 1 kw.-hr. operating as at present is 0.72c. during winter season, 2.2c. during summer season and 1.46c. average for the year.

TOTAL OPERATING COST FOR LIGHT AND POWER

	Winter Period	Summer Period	Total for Year
Proportional operating cost generating steam	$8,452.95	$30,742.75	$39,195.70
Engines and generators, maintenance, material and supplies	527.86	464.11	991.97
Interest on capital invested in engines, generators, switchboard and intermediate wiring ($49,400@6%)	1,482.00	1,482.00	2,964.00
Insurance and taxes on above apparatus ($49,400@2%)	294.00	294.00	588.00
Depreciation on above apparatus ($49,400@4%)	988.00	988.00	1,976.00
Total	$11,744.81	$33,970.86	$45,715.67
Kilowatts generated	1,640,150	1,540,700	3,180,850
Average cost to generate 1 kw.	$0.0072	$0.022	$0.0145

The average cost to generate 1 kw.-hr. of 0.72c. during winter period cannot be expected to improve very much, but it is reasonable to believe that the summer rate of 2.2c. can be reduced. In view of the fact that electrical power generating apparatus is installed and in operating condition, thereby having a fixed charge, also that a permanent engineering organization has been established with its accompanying fixed charges, it will be necessary to obtain a lower rate from parties selling power than 2.2c. per kw.-hr., the present unit cost during summer period. In order to ascertain the actual saving made and the maximum rate that could be paid if electrical power was purchased, the following tabulation was made:

FOR SUMMER PERIOD, SIX MONTHS

	Amount
Coal, 7500 tons, minus 2375 tons, @ $2.90	$14,862.50
Labor, 3 oilers @ $60 per month	1,080.00
Ash removed, 475 cars @ $2	950.00
Maintenance, material and supplies (from the first table)	464.11
Water, boiler make-up	150.00
Less depreciation on apparatus:	
One boiler and accessories, $13,600, @ 2%	272.00
Engines and accessories, $49,400, @ 1½%	741.00
	$18,519.61
Per kilowatt-hour	1.20

* Coal required for generating live steam necessary to help out exhaust steam demand.

This indicates that a lower rate than 1.2c. per kw.-hr. will have to be obtained in order to make any saving.

General conditions of plant: The power plant as a whole is in good operative condition and shows careful attention on the part of engineers in general upkeep and maintenance of machinery. Indicator cards off engines show good judgment has been exercised in setting valves, adapting them to best suit services that they perform.

Load Factors:

Total estimated number of lamps (56-watt) in house	22,500
Load factor, per cent	16
Total connected horsepower motors on 220 volts	431.85
Load factor, per cent	50½

Boiler evaporation test: The data and results of boiler-plant evaporative test are given in addenda herewith. The results are in accordance with good practice obtained from boilers of the type installed and quality of coal fired:

ENGINEERING DATA FOR YEAR ENDING FEBRUARY 28, 1911

	1910 March	April	May	June	July
Coal consumed under boiler in tons	2190.2	1888	1880	1770	1769
Pounds water evaporated per pound coal	5½	5¾	6⅞	6⅛	6⅛
Boiler horsepower generated	727,142	663,678	753,181	654,543	667,857
Lights, kilowatt consumption	156,830	108,160	146,742	142,510	110,000
Power, kilowatt consumption	116,000	110,000	97,828	110,500	108,910
Tons of ice made	193	208	234	249	248
Number cars ashes removed, Illinois Tunnel Co. cars	227	203	176	200	204

	1910 August	September	October	November	December
Coal consumed under boiler in tons	2068	2023	1779.8	1718.2	2032
Pounds water evaporated per pound coal	5¾	6¾	8⅛	7⅛	6 5/16
Boiler horsepower generated	746,708	833,213	947,876	786,587	806,580
Lights, kilowatt consumption	165,970	184,266	110,065	156,120	128,570
Power, kilowatt consumption	141,000	122,844	100,065	123,560	120,000
Tons of ice made	254	246	248	213	226
Number cars ashes removed, Illinois Tunnel Co. cars	229	223	131	101	150

	1911 January	February	Total for Year
Coal consumed under boiler in tons	2084 5	1623.1	22,825.8
Pounds water evaporated per pound coal	6 7/16	8⅛	Av. 6.8
Boiler horse power generated	860,454	865,691	9,313,510
Lights, kilowatt consumption	190,455	160,000	1,759,688
Power, kilowatt consumption	130,455	140,000	1,421,162
Tons of ice made	226	211	2,756
Number cars ashes removed, Illinois Tunnel Co. cars	168	121	2,133

OPERATING COST FOR GENERATING STEAM ONLY

For year ending February 28, 1911

Includes cost labor and material

	Cost for Winter Period	Cost for Summer Period	Total for Year
Boilers	$876.66	$1,231.15	$2,107.81
Pumps	437.91	468.92	906.83
Engine and boiler room	7,932.20	8,287.80	16,220.00
Ash removed	1,983.00	2,369.70	4,352.70
Coal	33,976.40	34,812.28	68,788.68
Water*	240.00	260.00	500.00
Insurance and taxes on steam generating apparatus and portion of building used by power plant ($236,200@2%)	2,362.00	2,362.00	4,724.00
Interest on capital invested in steam generating apparatus and portion of building used by power plant ($236,200@6%)	7,086.00	7,086.00	14,172.00
Depreciation on steam generating machinery ($104,000@4%)	2,080.00	2,080.00	4,160.00
Depreciation of portion of building occupied by power plant ($132,200@2%)	1,322.00	1,322.00	2,644.00
Total	$58,296.17	$60,279.85	$118,576.02

* Boiler make-up water only.

DATA AND RESULTS OF BOILER PLANT—EVAPORATIVE TEST

Total number boilers in battery, 5 at 400-hp. capacity.
Number boilers used in test, 3
Kind of fuel, Illinois coal, Carterville district, No. 3 washed nut.
Kind of furnace, combination water and fire-tube boilers manufactured by Lyons Bros., Depere, Wis.
Grate surface, 3x60 = 180 ft.; 3 x 2600 = 10,800 sq.ft.

TOTAL QUANTITIES

Date of trial	June 28, 1911
Duration of trial	22 hours
Weight of coal as fired	105,078 lb.
Percentage of moisture in coal	5.3%
Total weight of dry coal consumed	99,508 lb.
Total ash and refuse	10,800 lb.
Percentage of ash and refuse in dry coal	10.5
Total weight of water fed to the boiler	718,437 lb.
Water actually evaporated, corrected for moisture in steam	715,204
Factor of evaporation	1.0486
Equivalent water evaporated into dry steam from and at 212 deg. F.	749,962 lb.

Hourly Quantities	
Dry coal consumed per hour	4523
Dry coal per square foot of grate surface per hour	25.13
Water evaporated per hour corrected for quality of steam	32,509
Equivalent evaporation per hour from and at 212 deg.	34,089
Equivalent evaporation per hour from and at 212 deg. per square foot of water-heating surface	3.156
Average Pressures, Temperatures, Etc.	
Steam pressure by gage	150 lb. per sq.in.
Temperature of feed-water entering boiler	212 deg.
Temperature of escaping gases from boiler	609 deg.
Force of draft between damper and boiler	1.14 in. water
Percentage of moisture in steam	0.45
Horsepower	
Horsepower developed	988
Builders' rated horsepower	1200
Percentage of builders' rated horsepower	82.3
Economic Results	
Water apparently evaporated under actual conditions per pound of coal as fired	6.83
Equivalent evaporation from and at 212 deg. per pound of coal as fired	7.13
Equivalent evaporation from and at 212 deg. per pound of dry coal	7.54
Equivalent evaporation from and at 212 deg. per pound of combustible	8.45
Cost of Evaporation	
Cost of coal per ton of 2000 lb. delivered in boiler-room	$2 90
Cost of coal required for evaporating 34½ lb. of water from and at 212 deg. equivalent to one boiler horsepower	0.69

Readers should note the editorial in the Nov. 3 issue of POWER, on page 648, under the heading of "Small Leaks and Big Ones." The writer of that article not only shows his ignorance, but the tone of the article all the way through shows his disposition to injure a person with whom he was not acquainted and knows nothing of his ability whatsoever.

Note under heading of "Engineering Data" ending Feb. 28, 1911, that the average evaporation for the year equals 6.8 lb.; also that when good coal was purchased in February, 1911, and October, 1910, the evaporation averaged 8.67 lb. coal as fired.

J. E. LAWRENCE.

Chicago, Ill.

Asbestos-Packed Boiler Blowoff Cocks

All our asbestos-packed blowoff cocks were leaking badly, because the packing was worn and the stems cut. As new packing would cost within 30 per cent. as much as new cocks and believing that a good grade of babbitt would do just as well if not better, a mandrel was made, a set of cocks babbitted, the stems turned, ground in and the cocks placed in service. These worked satisfactorily and the others were repaired in the same way. The job was done by our own men and at much less cost than if sent to the factory.

It is over six months now, and they are still tight.

J. McL. BURNS.

Dover, N. J.

The Fireman Is a Chemist

Chemistry itself is without sin, but the sins of chemists are many. I note with interest a letter on this subject in the issue of Dec. 22, page 880. It is to be regretted that such a mistaken statement as "air is composed of hydrogen, oxygen and nitrogen" should have been allowed to go unchallenged, as it is a common one. It should be remembered, even by one who is not a practical chemist, that the air consists chiefly of nitrogen and oxygen, with some inactive argon, and some active carbonic-acid gas and water vapor.

I suppose the time will come when everyone will know more of the common facts accurately. Such a mistake is not only to be regretted, but it tells us that we must fight the battle for education again and again. Of course, if the air should contain any hydrogen, then the air would itself be not merely a supporter of combustion, but would be partly combustible, which, however desirable, is not the case.

The great lesson is that chemistry is something which is fundamental to almost every line of business and manufacture, and we should all learn to use it as it should be used, with safe and sane common-sense. Let the eternal battle-royal go on in the grand campaign of education. Make fun of chemists, as we fully deserve, but treat Chemistry well; she can speak for herself.

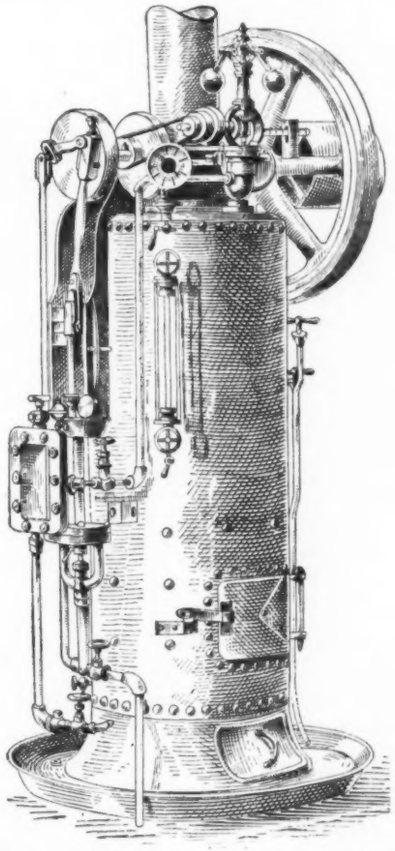
CHARLES S. PALMER.

Newtonville, Mass.

[The original was in error in a sense for it did not state that the hydrogen was not present as free hydrogen, but combined with oxygen in the form of vapor, often augmented by the use of steam jets.—EDITOR.]

Printers' Engine

In the Oct. 20 issue is an article on a self-contained steam plant which is interesting as a relic. The Buckeye Engine Co. had a similar idea and built a self-contained power plant called the "Printers' Engine." It was made in sizes from 1¼ to 15 hp. Recently some drawings which were made in 1872, showing the cylinder set in the



PRINTERS' ENGINE AS BUILT IN 1873

head of the boiler, were found at the works. The type of engine illustrated herewith, however, was successful and a number of them was sold.

D. J. MCCONNELL,
Buckeye Engine Co.

Salem, Ohio.

[The circular from which the accompanying illustration is produced is dated 1873.—EDITOR.]

Engineers' Study Course

Problems in Power-Plant Design--XIII

Comparing Steam Requirements with Available Exhaust

It was stated in the first article of the series that in designing a combined power and heating plant a comparison should be made between the steam requirements and available exhaust which should cover with a fair degree of accuracy the entire heating season.

In a general way, it is usually economical to employ the exhaust steam for heating purposes and to design the power plant with reference to that arrangement. Or, stated in another way, it is generally advisable, under average conditions, to install power and lighting plants in large buildings and to utilize the exhaust for heating. While this may be true ordinarily, the amount of saving will depend upon a number of conditions which may vary widely in different cases. Among these may be mentioned length of heating season, average winter temperature, type of engines used, method of heating, cost of fuel, water, labor, etc., and also, of the most importance, the relation between the steam required for heating and the available exhaust at different parts of the day.

The total exhaust from a plant in twenty-four hours may be equal to or exceed the heating requirements during the same length of time, but if it is not distributed so as to be utilized, a large amount may be thrown away at certain parts of the day which must be made up at other times by live steam taken from the boilers. From this it may be seen that total amounts of steam for the day are often misleading and a special study should be made of conditions from hour to hour (where there is much variation of load) for representative days of a considerable number of periods throughout the heating season. In the present case the available exhaust was assumed to be practically uniform throughout the year, and, furthermore, was found to exceed the heating requirements, so that a comparison of this kind was not necessary.

In other plants, especially those in office buildings, hotels, etc., where lighting and elevator service form a large part of the load, conditions will be found much more variable and tables or curves for comparison should always be prepared.

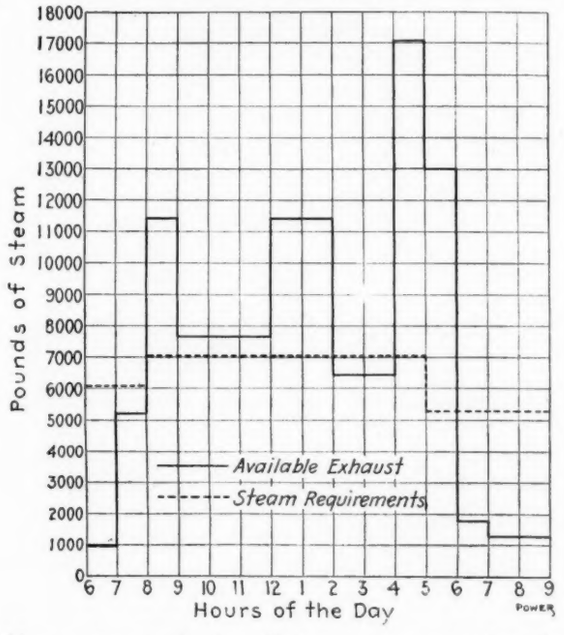
Power and Heat Requirements

In any given case the first step is to make up a schedule which shall represent the power and heat requirements for the heating season.

A good way to obtain average conditions is to divide the season into seven equal periods, extending from the middle of October to the middle of May, and from the weather records of previous years obtain the average temperature of each of these periods. If the plant is operated daytimes only, use the day temperatures, but if it is operated both day and night, as in a large hotel, then make up two lists, one of average temperatures from 6 o'clock in the morning until 6 at night, and the other for the remaining twelve hours. Designate them "day temperatures" and "night temperatures."

Next, make a list of all purposes for which steam is required in the building exclusive of that used for power. These will vary in different cases, but they will ordinarily include one or more of the following: Heating, ventilating, hot water for lavatories and baths, cooking, laundry service, sterilizing, mill work, such as drying, washing, finishing, etc., and dry kilns.

In a new plant the weight of steam required for each of the foregoing purposes per hour, with the exception of heating and ventilating, may usually be obtained from those installing the kinds of apparatus to be used. If the



problem concerns the installation of a power plant in a building already constructed and in use, tests should be made to determine the weight of steam actually required. In addition, the particular hours of the day during which steam is required for the various purposes should be noted as well as the weight used. The requirements for heating and ventilating may usually be computed with sufficient accuracy from the data given in previous articles of the present series, supplemented by certain corrections to be noted presently.

The heating system for a building is commonly proportioned for the coldest weather to which that particular locality is subject. If now the apparatus be provided with a system of automatic control, which shall gage the heat supplied to actual requirements, the weight of steam used per hour will vary directly as the difference between the inside and outside temperatures (neglecting the effect of high winds) and will change with each variation of outside temperature throughout the heating season. If, on the other hand, the entire radiating surface is kept turned on at all times or the heating plant is run at its

full capacity, the weight of steam used per hour will be practically the same for all outside temperatures, with a system of direct radiation, provided the inside temperature is maintained at 70 deg. by opening the windows. As a matter of fact, neither of these conditions ordinarily prevails, although the former is very nearly approached with the best systems of pneumatic control.

To approximate the steam requirement for heating with different outside temperatures, the weight of steam used per hour in zero weather must be multiplied by a factor corresponding to the actual outside temperature, and this in turn must be corrected for the type of temperature regulation employed. Assuming that the plant is designed for a minimum outside temperature of zero and the normal inside temperature of 70 deg., and that the system is accurately controlled to maintain this inside temperature without opening the windows or admitting cool air, the proportion of heat required for varying outside temperatures will be found in Table 1.

TABLE 1. HEAT REQUIREMENTS

Outside temperature, deg. F	0	+10	+20	+30	+40	+50	+60	+70
Proportion of heat required, as compared with zero conditions	1.00	0.86	0.72	0.57	0.43	0.29	0.15	0.00

For example, if 1000 lb. of steam is required for heating a given building with an outside temperature of zero only,

$$1000 \times 0.72 = 720 \ lb.$$

will be required when it is 20 deg. above, or

$$1000 \times 0.43 = 430 \ lb.$$

at 40 deg., etc. The next step is to assume certain factors to offset the steam wasted when different means of temperature regulation are employed. These factors can only be estimated, but for average conditions it may be assumed that with the best systems of automatic control the results given in Table 1 will be obtained. With forced hot-water circulation these should be multiplied by 1.2; with vacuum systems by 1.3, and with low-pressure gravity systems by 1.4.

For example, if 1000 lb. of steam is required per hour in zero weather with a low-pressure gravity system,

$$1000 \times 0.43 \times 1.4 = 602 \ lb.$$

will be required when it is 40 deg. above zero. In other words, 40 per cent. more radiation will be in use than is actually required for heating the building and the surplus heat will be wasted through open windows.

When ventilation is provided in large buildings by means of fans, the temperature of the entering air is accurately controlled, and Table 1 may be made use of, the same as for automatically controlled direct radiation. For example, if the weight of steam required for warming the air for ventilation is 3000 lb. per hr. in zero weather, it will be

$$3000 \times 0.57 = 1710 \ lb.$$

when the outside temperature is +30 deg.

After having determined the weight of steam required for all heating purposes for each hour of the average day of the first period, Oct. 15 to Nov. 15, the next step is to estimate the average indicated horsepower required for all power purposes for the corresponding period.

The power requirements will vary with the type of building and will commonly include a portion of the following: Driving machinery, lighting, elevator service, auxiliary pumps, refrigeration, ventilating fans, miscellaneous motors for kitchens, laundries, etc. As the power load will vary at different hours of the day, each hour should be taken up separately and the available exhaust computed for comparison with the steam requirements for heating during the corresponding hour. The total indicated horsepower multiplied by the water rate of the engine, and this result by 0.85, will give the available exhaust. In making a full study of this kind of problem the average day for each of the seven periods should be similarly worked out and the results either tabulated or plotted in curves for easy reference. Having shown the general method to be followed in such problems, it may be well to illustrate it by working out a simple example in detail.

Take the case of an office building requiring power for lighting, elevator service, auxiliary pumps and fan motors, and steam for heating, ventilation and hot-water service. Suppose the maximum requirements for each are found to be as follows: Lighting, 200 kw.; elevator service, 300 i.hp.; fan motors, 12 i.hp.; auxiliary pumps, 20 i.hp. All items rated in indicated horsepower are referred to the main engines and include the friction losses in the various machines. Let the period taken be from Dec. 15 to Jan. 15, when the lighting requirements are at a maximum, and assume them to be as follows:

Hour of Day	Kw.	I.Hp. at Engine
6 a.m. to 7 a.m.	10	18
7 a.m. to 8 a.m.	50	88
8 a.m. to 4 p.m.	70	124
4 p.m. to 6 p.m.	200	350
6 p.m. to 9 p.m.	40	70

In making out this schedule it has been assumed that each kilowatt delivered by the dynamo requires 1.75 i.hp. at the engine. The schedule of elevator service is assumed to be as follows:

Hour of Day	I.Hp. at Engine
7 a.m. to 8 a.m.	100
8 a.m. to 9 a.m.	300
9 a.m. to 12 noon	150
12 noon to 2 p.m.	300
2 p.m. to 4 p.m.	100
4 p.m. to 5 p.m.	300
5 p.m. to 6 p.m.	150
6 p.m. to 7 p.m.	50
7 p.m. to 9 p.m.	10

The various auxiliary pumps, including those for hot-water circulation for heating the building, are run continuously from 6 a.m. until 9 p.m. and require approximately 20 i.hp. at the main engines. Ventilation is provided for the first-floor stores and special offices and the fans are run from 8 a.m. till 5 p.m., at a uniform load of 12 i.hp. at the engine.

As the exhaust will be utilized for heating purposes, simple high-speed engines will be used having a water rate of approximately 30 lb. per hr. per i.hp., of which about

$$30 \times 0.85 = 25 \ lb.$$

will be available in the exhaust for heating purposes.

It is now possible to make out a schedule covering the entire day, giving the total indicated horsepower for all purposes and the pounds of available exhaust for each hour.

TABLE 2. SCHEDULE OF AVAILABLE EXHAUST

Hour of Day	I.Hp. for Different Purposes A	B	C	D	Total I.Hp.	Pounds per Hour of Available Exhaust (I.Hp. x 25)
6 to 7	20 + 18				38	950
7 to 8	20 + 88 + 100				208	5,200
8 to 9	20 + 124 + 300 + 12				456	11,400
9 to 10	20 + 124 + 150 + 12				306	7,650
10 to 11	20 + 124 + 150 + 12				306	7,650
11 to 12	20 + 124 + 150 + 12				306	7,650
12 to 1	20 + 124 + 300 + 12				456	11,400
1 to 2	20 + 124 + 300 + 12				456	11,400
2 to 3	20 + 124 + 100 + 12				256	6,400
3 to 4	20 + 124 + 100 + 12				256	6,400
4 to 5	20 + 350 + 300 + 12				682	17,050
5 to 6	20 + 350 + 150				520	13,000
6 to 7	20 + 70 + 50				140	3,500
7 to 8	20 + 70 + 10				100	2,500
8 to 9	20 + 70 + 10				100	2,500

In the above schedule column A represents power for

auxiliary pumps; B, electric lighting; C, elevators; and D, ventilating fans.

The next step is to prepare a similar schedule for the heating requirements. Suppose the computations show the total heat necessary for warming the building in zero weather to be 5,700,000 B.t.u. per hr., and for ventilating purposes 2,000,000 B.t.u. per hr. Furthermore, suppose that the weather records for the past five years show the average day temperature to have been +20 deg. for this period. Let the circulating pumps for the heating system be started at 6 a.m. and stopped at 9 p.m., and assume that two hours are required for warming the building up to 70 deg., so that from 6 to 8 in the morning during this month the plant will be run at its full capacity regardless of the outside temperature. Although the building is to be warmed with hot water, the steam requirements will be the same as though it were condensed in the radiators instead of in a special heater.

Taking the latent heat of exhaust steam as 970 and the factor for hot-water regulation as 1.2, we have the following conditions and results: During the period from 6 till 8 a.m. the total capacity of the heating plant will be required and utilized, or

$$\frac{5{,}700{,}000}{970} = 5876 \text{ } lb.$$

or practically 5900 lb. of steam will be used per hour. For the remainder of the day this will amount to

$$5900 \times 0.72 \times 1.2 = 5097 \text{ } lb. \text{ } per \text{ } hr.$$

Heat for ventilating purposes amounts to

$$2{,}000{,}000 \times 0.72 \times 1.2 = 1{,}728{,}000 \text{ } B.t.u.$$

$$\frac{1{,}728{,}000}{970} = 1781 \text{ } lb. \text{ } per \text{ } hr.$$

from 8 a.m. till 5 p.m. Buildings of this kind are usually supplied with a hot-water storage tank so that any variation in the demand for hot water during the day is cared for in this way.

In the present case, steam will be on the tank continuously from 6 a.m. till 9 p.m. and it may be assumed that 150 lb. of steam per hour is required for this purpose throughout the day. The data are placed in tabular form, the same as for the power requirements, in Table 3.

TABLE 3. SCHEDULE OF STEAM REQUIREMENTS

Hour of Day	Lb. Steam per Hr. for Heating	Lb. Steam per Hr. for Ventilation	Lb. Steam per Hr. for Hot Water	Total Steam Requirements, Lb. per Hr.
6 to 7	5,900	.....	150	6,050
7 to 8	5,900	.....	150	6,050
8 to 9	5,097	1,789	150	7,036
9 to 10	5,097	1,789	150	7,036
10 to 11	5,097	1,789	150	7,036
11 to 12	5,097	1,789	150	7,036
12 to 1	5,097	1,789	150	7,036
1 to 2	5,097	1,789	150	7,036
2 to 3	5,097	1,789	150	7,036
3 to 4	5,097	1,789	150	7,036
4 to 5	5,097	1,789	150	7,036
5 to 6	5,097	.....	150	5,247
6 to 7	5,097	.....	150	5,247
7 to 8	5,097	.....	150	5,247
8 to 9	5,097	.....	150	5,247

As a matter of fact, the outside temperature will vary more or less during the day, but as this is so irregular in its action it is difficult to allow for it unless the number of hours for each temperature is tabulated. For approximate work it is usually sufficiently accurate to use constant temperatures throughout the day and night periods. In the present case a constant temperature has been assumed for the entire heating period from 6 a.m. till 9 p.m. Table 4 compares steam requirements and available exhaust and shows the weight of live steam required and exhaust wasted for each hour during the day.

TABLE 4. SCHEDULE OF COMPARISONS

Hour of Day	Steam Requirements, Lb.	Available Exhaust, Lb.	Live Steam Used, Lb.	Exhaust Wasted, Lb.
6 to 7	6,050	950	5,100	.....
7 to 8	6,050	5,200	850	.....
8 to 9	7,036	11,400	.....	4,364
9 to 10	7,036	7,650	.....	614
10 to 11	7,036	7,650	.....	614
11 to 12	7,036	7,650	.....	614
12 to 1	7,036	11,400	.....	4,364
1 to 2	7,036	11,400	.....	4,364
2 to 3	7,036	6,400	636	.....
3 to 4	7,036	6,400	636	.....
4 to 5	7,036	17,050	.....	10,014
5 to 6	5,247	13,000	.....	7,753
6 to 7	5,247	3,500	1,747	.....
7 to 8	5,247	2,500	2,747	.....
8 to 9	5,247	2,500	2,747	.....
Total.....	96,412	114,650	14,463	32,701

Referring to Table 4, it is seen that while the available exhaust for the day is

$$114{,}650 - 96{,}412 = 18{,}238 \text{ } lb.$$

more than the total steam requirements for heating, it is so distributed that 32,701 lb. are wasted and 14,463 lb. of live steam must be taken from the boilers to make up the deficiency. This illustrates the point noted at the beginning of the article—that total steam quantities for the day should not be relied upon when making comparison of steam requirements and available exhaust. To make the comparison complete, this same process should be gone through with for an average day for each month of the heating season.

In large plants, where there is considerable variation in power and heating conditions from month to month, it may be advisable to take shorter periods, say every week or ten days. The accompanying diagram is a plot of the heat requirements and the available exhaust. This shows at a glance the relation of one to the other throughout the day.

American Association for the Advancement of Science

The 66th meeting of the American Association for the Advancement of Science held at Philadelphia, Penn., Dec. 28, 1914, to Jan. 2, 1915, was attended by 1500 to 2000 members and guests coming from every part of the United States. Nearly every university, Federal department, state or city government which employs scientific investigators was represented and the Philadelphia meeting recently brought to a close was undoubtedly the most successful in scope of subjects and in point of attendance of any since the organization of the association in 1847.

There are 12 sections of the association, comprising mathematics and astronomy, physics, chemistry, engineering, geology and geography, zoology, botany, anthropology and psychology, social and economic science, physiology and experimental medicine, education, agriculture.

The programs of the different sections each included anywhere from five to one hundred addresses and communications in their respective fields of scientific research. The sections and 24 affiliated societies held their principal sessions in the various halls, lecture rooms and laboratories of the University of Pennsylvania, which afforded admirable accommodations. Dr Charles W. Eliot, president emeritus of Harvard University, was elected president of the association for the ensuing year. At the first general session the retiring president, Dr. Edmund D. Wilson, in delivering his annual address, said that "the scientific method is the mechanistic method which produces practical results. The moment we swerve from it by a single step we set foot on a foreign land."

Frederick W. Taylor, one of the vice-presidents of the association, presided at the sessions of the engineering section which were held Dec. 30 and 31 in the Engineering Building of the university. Seventy-five papers and addresses were presented on various subjects of industrial, hydraulic and civil engineering, the latter including 30 papers on highway construction and pavements.

The next regular meeting of the association will be held at San Francisco, Calif., Aug. 2 to 7, 1915. As this will be during the Panama-Pacific Exposition, it is expected that the meeting will be largely attended.

Testing Liquid Flow Meters*

By W. S. Giele

SYNOPSIS—Description of a laboratory for testing and calibrating liquid flow meters by means of direct comparison of like quantities, such as volumes, inches of water head, and rates per unit time.

The laboratory herein described was designed and built to facilitate the investigation and testing of liquid flow meters, with special reference to those of the V-notch weir type. This type consists essentially of a rectangular chamber containing a vertical dividing wall with a V-notch weir plate attached to the upper part. On one side is the "approach" chamber provided with suitable baffles, and on the other, the "outflow" chamber which receives the discharge of the notch, and from which water passes to boiler feed pumps or other places of delivery. This meter is provided with an autographic recording device, giving a continuous record from which the instantaneous rate of flow may be read, while also permitting a continuous integration of quantity.

The indicating, recording and integrating instruments will be best understood by reference to Fig. 1. A float in either

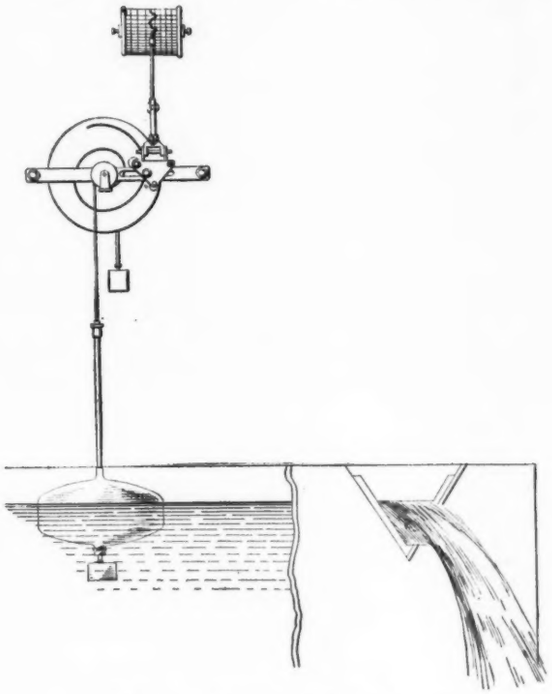


Fig. 1. Recording Devices

the approach chamber or a chamber in communication therewith, bears a vertical stem, actuating (by means of a cable and drum) a revolvable cam, which is adapted to displace a pen carriage or integrating train equal distances for equal increments in the rate of flow. For convenience in manufacture and use, it is desirable that one standard height of chart be employed for all capacities, and that this chart be subdivided decimally. With arbitrarily selected weir-notch angles this might be attained by cutting a different cam for each capacity, but it is much easier to use one standard cam, embodying the relation between the rate of flow and the head of water on the notch, and to accomplish the adaptation to different rates of flow by varying the diameter of the cable drum and the angle of the notch itself; thus making it necessary to establish accurately the relation between the coefficient of the notch and the angle.

The method decided upon was to construct a master flow meter so arranged that the rate of flow could be maintained accurately at any desired value for long periods; and after having determined with precision the performance of this standard, to use it as a means of measuring the flow through the meters which it is desired to investigate.

By this means of direct comparison, a degree of accuracy can be secured in the meter under test practically equal to that of the standard. Such a standard having once been accurately calibrated, disturbing influences arising from the effects of proportions of the channel of approach, conditions

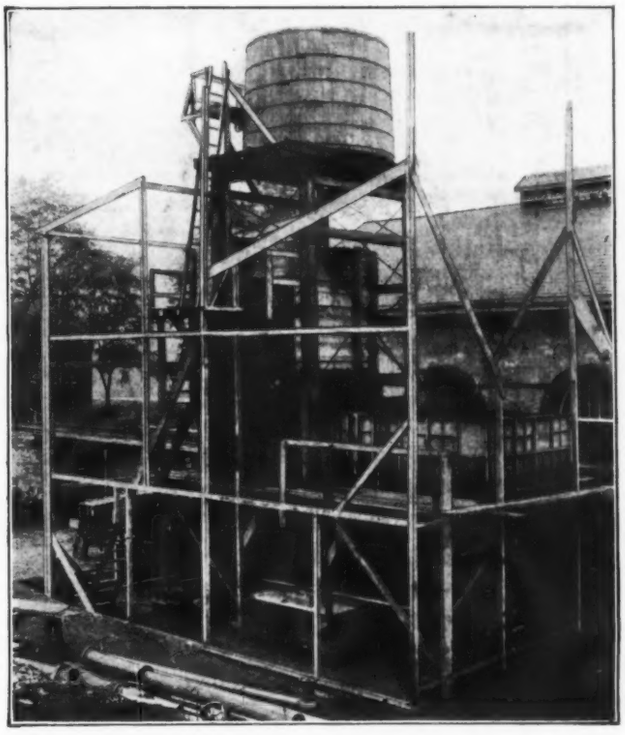


Fig. 2. General View of Meter-Testing Plant

of surfaces, form and material of notch, directions and interference of currents of flow in the channel of approach, etc., can be ignored.

It is estimated that by this method greater accuracy can be obtained in a run of one-half hour at a low head than would be possible in a run of fifteen hours at the same head, using either volumetric or gravimetric methods.

DESCRIPTION OF APPARATUS

As shown in Figs. 2 and 3, the testing plant has a large storage tank from which the water is drawn by a pump and elevated to a supply or constant-head tank at the highest level, its purpose being to supply water to a discharge orifice at a constant head so that the rate of flow through the standard notch may be maintained invariable at any desired capacity.

From the constant-head tank the water passes to the standard-notch tank, thence flows over the calibrated notch into the meter under test, whence it is discharged to the storage tank to circulate again.

During the preliminary work on the calibration of the standard notch, instead of passing from the standard notch to the meter under test, the water flowed alternately to either of two volumetric measuring tanks, from which it discharged into the storage tank to resume its course.

In view of the necessity for permanent maintenance of conditions under all circumstances, the entire plant was constructed with the utmost regard to permanency and rigidity. The foundation consists of a concrete slab approximately 24 ft. long by 10 ft. wide, carried to solid clay soil and reinforced in all directions by 1-in. rods.

The storage tank rests directly on the concrete foundation and holds a little over 1000 cu.ft. of water. The supply to the pump is through an 8-in. opening located with its center

*Excerpts from a paper before the American Society of Mechanical Engineers, at New York, Dec. 4. 1914.

about 8 in. above the bottom of the tank (to eliminate sludge which might accumulate on the bottom), and 12 in. from the vertical center line of the end of the tank. It is also supplied with a 3-in. drain at its lowest point and with a system of steam pipes whereby the water may be heated to the desired temperature.

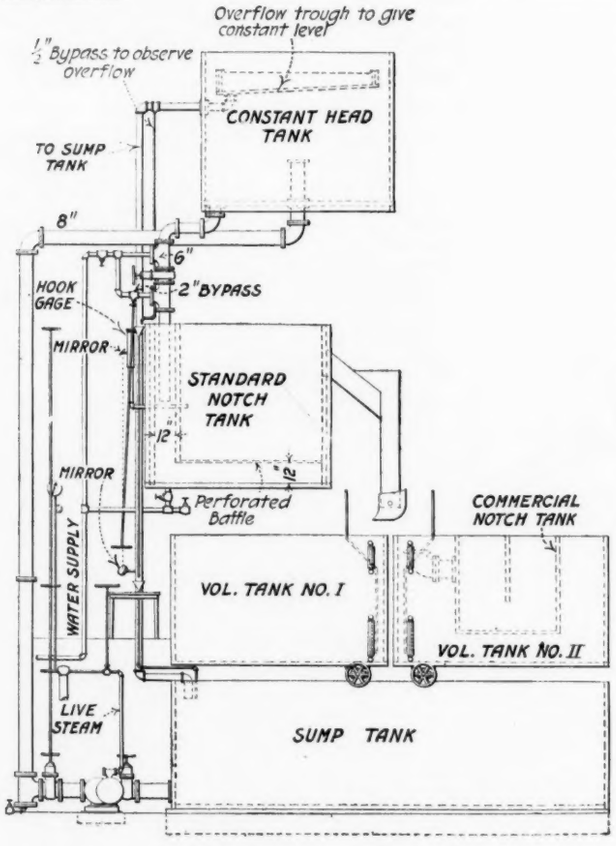


FIG. 3. ELEVATION OF TESTING PLANT

The pumping unit is an 8-in. single-stage, centrifugal pump about 4 ft. from the end of the storage tank. It is gear-driven by a single-stage steam turbine, and has a capacity of about 120 cu.ft. per min. against the head of the highest tank, which corresponds to a flow of about 450,000 lb. per hr.

The outlet from the constant-head tank is a 6-in. line taken from the bottom and as close to the side as possible. This arrangement was adopted after experiments looking toward the prevention of a swirling motion within the tank.

The maintenance of a practically constant head in this tank is essential to a constant flow through the system. This is accomplished by the installation of an overflow weir consisting of a rectangular trough 8 ft. 8 in. long, having inflow edges or weirs on both sides. These edges are constructed of metal and were carefully brought into a horizontal plane so that the discharge would be uniform throughout their length. The overflow at these edges is carried by a 4-in. pipe line back to the storage tank, this line being provided with a ½-in. bypass discharging into open funnels on both the standard notch level and the observation room level so that the observer may constantly watch the overflow and thereby judge of the constancy of the head.

The approximate amount of water in the constant-head tank is indicated by a float to which is attached a chain passing over sheaves and extending to the pump room with pointers at each level.

The outlet pipe for the constant-head tank into the standard-notch tank contains a 6-in. valve for roughly setting the larger flows and a 2-in. valve in a bypass carried around the 6-in. valve for fine adjustment. The stem of this 2-in. valve is carried down to the observation station so that the flow may be accurately controlled from that point.

Every precaution has been taken to prevent change in shape or position of the standard notch. It rests on a structural steel platform supported by heavy, rigidly braced columns carried outside the volumetric measuring and storage tanks directly to the foundations, the column loads being distributed on the foundation by two 15-in. I-beams, grouted in. The standard V-notch is approximately 22½ in. high by 11¼ in. wide at the top, and its full capacity at 18¼ in. head is roughly 110 cu.ft. per min.

The standard-notch tank is divided into two compartments by a rigid partition 1 ft. from the end opposite the notch and ending 1 ft. above the bottom. The supply line discharges behind this partition 2 ft. below the surface of the water, and the water finds its way under the partition, spreads out over the bottom of the tank and rises through a perforated baffle having approximately 2000 holes ¾ in. square. This arrangement has resulted in a quiet surface of approach, even at the highest rates of flow.

It was not necessary to find the apex or zero level of the standard notch with extreme precision, it being necessary only to provide a reference point from which measurements could always be taken, and which would be immovable with respect to the notch itself. This reference point consists of a hook gage securely soldered to the notch with its point in a plane normal to the plane of the notch through its vertical center line and ½ in. away from it. The level of the water above the zero level is read by a second adjustable hook gage attached to the opposite end of the tank.

As any tilting of the tank would not only change the cross-section of the stream issuing from the notch, but also the relation between the hook gage by which the level is read and the notch, the care in supporting the tank is further checked by means of special gages to indicate any deflection in the tank or supports. These special gages consist of four glass tubes with three reference lines, spaced 9 in. apart, etched entirely around each. The four gage glasses are firmly attached at the four corners of the standard-notch tank.

The level of the water flowing through the standard-notch is obtained by means of a specially designed hook gage connecting with the still-water chamber. The special and unusual construction of this hook gage arises chiefly from the extreme range of height which it must cover and the consequent possibilities of error resulting from differences in temperature between the various parts of the gage itself at various times, and also between the water column within the gage tube and the temperature of the water in the still-water chamber. To eliminate the effect of temperature changes in the gage itself, the elements were so constructed that expansions due to increased temperature would tend to compensate each other. To eliminate the effect of differences of temperature between the two water columns, the hook gage tube was jacketed by flowing water taken from the same source of supply as that to the still-water chamber. The hook itself has a 60-deg. point and is constructed as shown in Fig. 4.

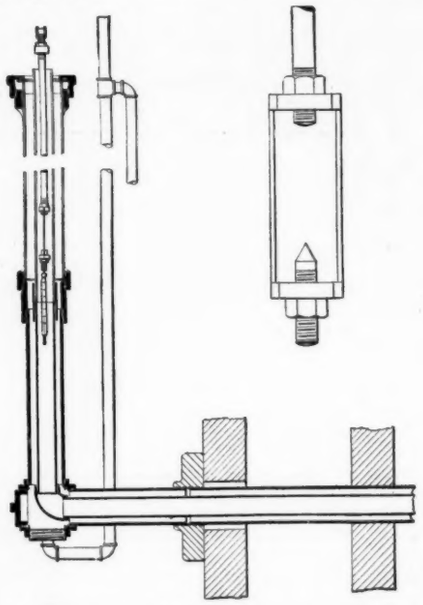


FIG. 4. SHOWING ARRANGEMENT OF HOOK GAGE

The register of the point of the hook with the surface of the water is observed from below the water surface, in which position it is possible to see both the hook itself and the reflected image on the surface of the water. The hook is at the water surface when the point of the reflected image coincides with the point of the hook. Any deviation from this position is observed as double the distance between the point of the hook and the water surface, thus permitting exactness in this observation, which is further promoted by the fact that the reading is taken through a magnifying

lens and reflected downward and horizontally by a mirror to the observation station, at which point a four-power binocular is rigidly supported for observation. The hook is illuminated by means of a frosted incandescent bulb.

Owing to the number of readings to be taken and the space covered by the plant, special means were necessary to bring all observations and controls to a central observation station. Fig. 5 is an interior view of the observation room showing the desk from which observations are taken.

When running tests, it is necessary only to observe that the water level remains at the point of the hook and it is not necessary to read the height of the hook gage on the standard-notch tank during the progress of an experiment. A similar hook gage is applied to the meter under test with the addition of an extended shaft bringing the graduated scale to the observation room where the operator can read the height of water passing over the weir under test. This reading is taken immediately above the eye pieces of the binoculars through which is observed the coincidence of the water surface and the hook.

It was determined after several experiments that the hook and hook rod must be relieved of all strains and left free to align themselves by gravity. While with the jacketed

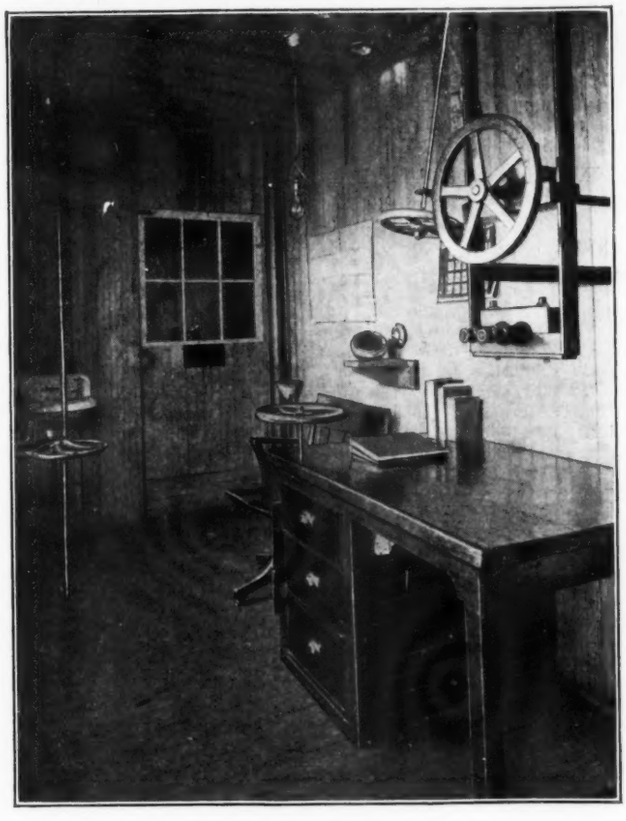


FIG. 5. OBSERVATION ROOM

arrangement it was never possible to detect a difference in temperature between the water in the hook gage tube and in the still-water chamber exceeding ½ deg. F. during the course of a whole day, it is interesting to note the results which might be obtained from an unjacketed gage. Without the jacket water it was found that a difference of 20 deg. F. (from 50 to 70 deg.) was entirely possible and effected a vertical head of 30 in. of water. The reading of the gage under such conditions would be 0.048 in. in error.

In investigating the effects of temperature changes on the parts of the gage it is to be noted that the vertical sheave support in its expansion will compensate for the elongation of the cable due to temperature, and that the expansion of the drum will tend to compensate for the elongation of the hook rod between the point of the hook and the attachment of the cable.

In preparing for the calibration of the standard notch, a curve was plotted, indicating the ideal conditions of flow, which the experiments would approximate. This curve was then divided into sections so that these could be separately plotted from the empirical data obtained to a much larger scale. After having mapped out the points it was desired to plot on the curve it was necessary only to set the hook gage at heads corresponding to these points and start the circulation of water through the system. After bringing the flow up to the desired head by manipulation of the control valves, readings were taken at regular and frequent intervals, until a sufficient number had been obtained showing uniform conditions, to furnish data for the necessary computations with assurance of reliability.

Municipal Plant Not to Extend Service

A recent bill passed by the city council of Seattle to permit the municipal lighting plant to extend its service beyond the city limits to serve rural districts has been vetoed by the mayor. The council refused to pass the bill over the mayor's veto. In refusing to adopt the plan of extending the city lighting system to outlying communities, Mayor Gill said in part:

"To say that the Seattle lighting plant is a money-making concern in the sense that it earns money for the general purpose of reducing taxation is wrong. From its inception the lighting plant has controlled the rates of this city. It has saved our business men, taxpayers and residents many millions of dollars and will continue to do so unless it is brought into disrepute and made a political plaything.

"Under this theory of outside extensions there is no reason why the city of Seattle should not engage in any other commercial business and conduct grocery stores, drygoods stores and other profit-making concerns. All there is embodied in this bill is pure socialism and opportunity given to settle the grudges of certain persons arising from real or imaginary grievances against a private corporation.

"The financial condition of our lighting plant at the present time is due to gross financial mismanagement by the council for the past three years. The councilmen refused to comply with the recommendations of former Chief of Police Griffiths and myself, and light downtown alleys, giving as an excuse that they had no money, although they are now preparing to become 'wet nurse' for the suburban districts outside the city limits, and are far worse off financially now than then. I have always maintained that the plant should seek a fair return on the money invested and the amount so earned be expended within the limits of the city to the end that all our people should have light at the lowest cost consistent with good business management.

"The tax rate of the city during the past few years has increased at a highly unprecedented rate, and we have nothing to show therefor except a street car line which was not intended to accommodate the public and which did not even accomplish the purpose of is principal promotors. As a matter of fact, there is no money in the light fund."

Research Fellowships at Illinois University

To extend and strengthen the field of its graduate work in engineering, the University of Illinois has since 1907 maintained ten research fellowships in the engineering experiment station. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. Appointments are made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the master's degree will be granted. Not more than half of the time of the research fellows is rquired in connection with the work of the department to which they are assigned, the remainder of the time being available for graduate study.

Nominations to fellowships, accompanied by assignments to special departments of the engineering experiment station, are made from applications received by the director of the station each year not later than the first day of February. These nominations are made within the month of February by the station staff, subject to the approval of the faculty of the graduate school and the president of the university. Appointments are made in March, and they take effect the first day of the following September.

Nominations are based upon the character, scholastic attainments, and promise of success in the principal line of study or research to which the candidate proposes to devote himself. Preference is given those applicants who have had some practical engineering experience following their undergraduate work. Research work may be undertaken in architecture, architectural engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, rail-

way engineering, and in theoretical and applied mechanics. The work of the station is closely related to that of the college of engineering, and the heads of departments in the college constitute the administrative station staff. Investigations are carried on by the members of the staff and other members of the instructional force of the college of engineering, by special investigators employed by the station, and by the research fellows. Four vacancies are to be filled at the close of the current academic year. Additional information may be obtained by addressing the director of the engineering experiment station, University of Illinois, Urbana, Ill.

3000-Volt Direct-Current Electrification

Plans for the electrification of the Puget Sound lines of the Chicago, Milwaukee & St. Paul Ry. have now been completed and contracts let to the General Electric Co. for the electric locomotives, substation apparatus and line material, and to the Montana Power Co. for the construction of the transmission and trolley lines. This initial electrification of 113 miles of main line between Three Forks and Deer Lodge is the first step toward the electrification of four engine divisions extending from Harlowton, Mont., to Avery, Idaho, a total distance of approximately 440 miles. Later on, it is understood, the electrification will extend to the coast.

The Montana Power Co. covers a large section of Montana and part of Idaho with its network of transmission lines, which are fed from a number of sources of which the principal ones are:

Madison River	11,000 kw.
Cañon Ferry	7,500 kw.
Hauser Lake	14,000 kw.
Big Hole	3,000 kw.
Butte (steam turbine)	5,000 kw.
Rainbow Falls	21,000 kw.
Small powers aggregating	7,390 kw.
Total developed	68,890 kw.

Further developments, part of which are under construction, are:

Great Falls	85,000 kw.
Holter	30,000 kw.
Thompson Falls	30,000 kw.
Snake River	20,000 kw.
Missoula River	10,000 kw.
Total	175,000 kw.
Total capacity developed and undeveloped	244,000 kw.

The several power sites are interconnected by transmission lines, operating at 50,000 volts for the earlier installations and at 100,000 volts for later installations.

The railway company will purchase power at a contract rate of $0.00536 per kw.-hr., based on a 60 per cent. load factor. It is expected under these conditions that the cost of power for operating the locomotives will be considerably less than is now expended for coal.

In order to connect the substations with the several feeding-in points of the Montana Power transmission lines, a tie-in transmission line is being built by the railway company that will permit feeding each substation from two directions and from two or more sources of power. This transmission line will operate at 100,000 volts.

The immediate electrification will include four substations containing step-down transformers and motor-generator sets with necessary switchboard apparatus to convert 100,000-volt, 60-cycle, three-phase current to 3000 volts direct current. This is the first direct-current installation using such a high potential as 3000 volts, and this system was adopted in preference to all others after a careful investigation extending over two years.

SUBSTATIONS

The substation sites of the electrified zone provide for an average intervening distance of approximately 35 miles.

The substations will be of the indoor type, with three-phase, oil-cooled transformers reducing from 100,000 to 2300 volts, at which potential the synchronous motors will operate. The transformers will be rated 1900 and 2500 kv.-a. and will be provided with four 2½ per cent. taps in the primary and 50 per cent. starting taps in the secondary.

The motor-generator sets will each comprise a 60-cycle synchronous motor driving two 1500-volt direct-current generators connected permanently in series for 3000 volts. The fields of both the synchronous motor and direct-current generators will be separately excited by small generators direct-connected to each end of the motor-generator shaft. The generators will be compound wound, will maintain constant potential up to 150 per cent. load and will have a capacity for momentary overloads of 300 per cent. normal rating. To insure good commutation on these overloads, the generators will be equipped with commutating poles and compensating pole-face windings. The synchronous motors will also be utilized as synchronous condensers, and it is expected that the transmission line voltage can be so regulated thereby as to eliminate any effect of the fluctuating railway load.

Water-Power Bills before Congress

There were two bills introduced during the session of Congress just closed, each of which is of considerable importance and will have a controlling influence over future water-power projects if enacted into law. On careful reading, there seems to be no conflict of purpose at present or likely to arise from the enaction of both bills.

The Adamson bill deals exclusively with navigable waters, consequently with projects of considerable magnitude, while the Ferris bill deals with water-power development within the public lands and reservations of the United States. The Adamson bill, the first introduced, is an act to amend "An act to regulate the construction of dams across navigable waters," approved June, 1906, amended June, 1910, and is in general terms as follows: Authority is vested in the Secretary of War and the chief of engineers of the War Department to grant persons of proper status the right to construct and maintain a dam across or in any of the navigable waters of the United States, after obtaining approval of the plans, on condition that such persons shall maintain without expense to the United States such locks, booms, sluices or other structures which may then be deemed necessary. Also in case of future necessity, the grantee must furnish free water power or power generated from water power for the use of the United States for such construction. Provision is made for certain reimbursement to the United States for expenses incurred with reference to the project and also for funds to restore conditions whenever it shall be determined that navigation has been injured. It specifically states that the interests of navigation shall be paramount to the use of such dam for power purposes and that the grantee at his own expense shall maintain necessary lights and signals to aid navigation and such fishways as shall be prescribed by the Secretary of Commerce.

That persons constructing or maintaining any dam, etc., shall be liable for damage to private property by overflow or otherwise.

It shall be a misdemeanor punishable by a fine not exceeding $1000 a month to fail or refuse to comply with the lawful order of the Secretary of War, and if such failure or refusal is continued, all rights shall be revoked by a decree of the court. If such dam be declared an unreasonable obstruction to navigation its removal may be ordered at the expense of the grantee. The rights granted under this act shall continue for a period of 50 years after the completion of the dam, and after the expiration of that time such rights shall continue until compensation has been made for a fair value of the property as Congress may deem wise, unless revoked for cause.

After the expiration of 50 years, and on giving notice of one year, the United States may take over all of the property upon paying the fair value, together with the cost to the grantee of the locks or other aids to navigation and all other capital expenditures. The fair values shall be determined by an agreement between the Secretary of War and the owners, or by legal proceedings instituted by the United States, but no claim for the franchise, good will or pending contracts shall be made.

Provision is made to regulate the charges for service to the customers which shall be just and reasonable, and discriminatory charge is specifically prohibited and declared to be illegal. The Secretary of War is empowered to prescribe what shall be the just and reasonable rates in certain states, and in case of violation, certain provisions relative to forfeiture are applied. The valuation for rate-making purposes is to be based on all capital and expenditures required. The jurisdiction of the Secretary of War is provided only for states not provided with adequate laws for the regulation of rates, etc.

Another provision is that no works constructed under the provision of this act may form a part of or in any manner affect a combination or an unlawful trust, but it shall be lawful for different grantees to exchange and interchange current, to assist one another whenever necessary under regulations prescribed by the Secretary of War, but in no case to raise the price or operate in restraint of trade.

This act shall not apply to irrigation or power dams or other projects under the jurisdiction of the Secretary of the Interior or the Secretary of Agriculture upon public lands of the United States.

The Ferris bill vests in the Secretary of the Interior authority to lease to citizens of the United States, or those who have declared their intention to become such, for a period not longer than 50 years, the right to construct and maintain dams, etc., for the generation and distribution of hydro-electric power when the project will not injure a forest or national reservation. It gives preference to developments by states, counties, etc., for municipal uses and purposes, and also specifies that the lessee shall at no time, without the consent of the Secretary of the Interior, contract for the delivery to any one customer of electric energy in excess of 50 percentum of the total output. The physical combination of plants may be permitted in the discretion of the Secretary, but combinations to limit the output of electrical energy, to restrain trade or increase prices are forbidden, and, except upon written consent of the Secretary of the Interior, no sale or delivery of power shall be made to a distributing company, except in case of emergency, and then only for a period not exceeding 30 days.

Upon not less than three years' notice prior to the expiration of the lease, the United States may take over the properties upon condition that it shall pay the actual cost of the various items and the reasonable value of all property taken over, the value to be determined by mutual agreement between the Secretary of the Interior and the lessee. Such value shall not include the franchise, good will or other intangible elements. In the event the United States does not take over the properties a new lease may be granted.

For the occupancy of public lands, the Secretary of the Interior is authorized to collect charges or rentals, the proceeds to be paid into the reclamation fund under the Reclamation act, and upon the return to the reclamation fund of such moneys, 50 percentum shall be paid by the Secretary of the Treasury to the state within the boundaries of which the hydro-electric power is generated, said moneys to be used by the state for the support of public schools or for public improvements. Leases by municipal corporations solely for municipal use shall be issued without rental charges, and leases for development not in excess of 25 hp. may be issued to individuals or associations for domestic, mining or irrigation use without charge.

In states not provided with a commission to regulate rates, the Secretary of the Interior shall be vested with power to regulate such rates until such a time as the state shall provide a commission.

Where the Secretary of the Interior determines that land values will not be materially injured, power projects will be permitted, where rights now granted for the use of public lands for the purpose of irrigation or mining alone are not abridged.

The Secretary of the Interior is authorized to examine the books and accounts of lessees and require reports upon oath, and making false statements is subject to punishment as for perjury.

The final provision is made for the transfer of permits under the provision of any previous law to the present one.

Boiler and Stoker Test from Banked Fire

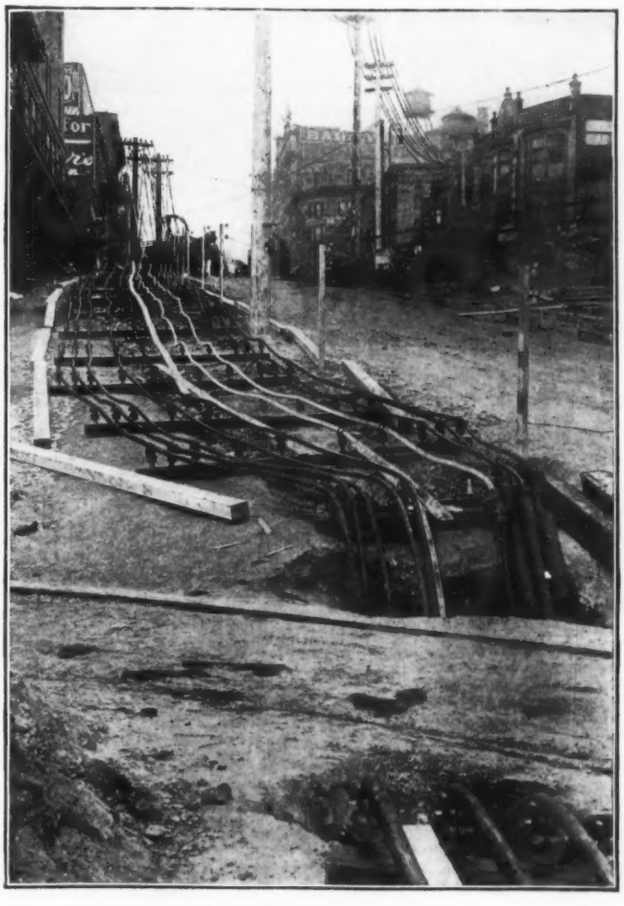
In a test made recently at the Scott Street steam station of the Toronto Electric Light Co., Ltd., Toronto, Canada, a 554-hp. Babcock & Wilcox boiler equipped with a Riley stoker was brought up to 354 per cent. of its rating in seven minutes. This performance was made possible by the moving grates of this type of underfeed stoker. The fire at once becomes active, because when starting up the stoker the moving grates also start, breaking up the fuel bed so that the air enters quickly for active combustion.

Before starting this test the boiler pressure was just below the normal pressure of 150 lb., and sufficient coal was being fed to maintain this condition. The signal to start the stoker fan was given when the steam pressure had dropped 5 lb. below normal, and this was taken as the time of starting the test. The load on the boilers was figured from switchboard kilowatt reading, figuring back through the turbine water rate, corrected for radiation losses. The turbine water rate was checked by a hot-water meter in the feed line. The turbine was called in at 9:36 a.m.; reported ready for load 3¾ minutes later. It was synchronized 41½ minutes past 9, but the stoker fan had started at 9:39. At 9:44 the load was 900 kw., equivalent to 95 per cent. of the boiler rating. Then the load went to 1700 kw., which was equivalent to 201 per cent. of the boiler rating, and at 9.46, seven minutes after the stoker and fan started, the load was 3000 kw., or 354 per cent. of the boiler rating.

This plant is used as a standby for the hydroelectric power generated at Niagara Falls. It is maintained with live banked fires in readiness to pick up the load in case of interruption to the hydro-electric power supply. This steam station contains four 554-hp. water-tube boilers, each equipped with a six-retort Riley self-dumping underfeed stoker. Forced draft for the stokers is supplied by a blower directly connected to a 125-hp. direct-current motor.

Temporary Repair Work at Cleveland

Following the fire in the three manholes and 150 ft. of feeder ducts, which temporarily paralyzed electric service in Cleveland's business district, as reported in the Dec. 29 issue, the Cleveland Electric Illuminating Co. took vigorous measures to restore service. The photograph shows the temporary cables with cross-arm spacers laid on the ground over Vinegar Hill. The cross-arms were later raised 30 in. above the ground. These temporary cables follow the line of the burned out ducts, which were immediately below, and were spliced onto the undamaged ends of the power-house feeders, it



TEMPORARY FEEDERS

being necessary to tear out a part of the duct line to get at these as the nearest manhole was badly damaged.

In addition to these a temporary overhead line of 10 cables was strung from the terminal pole, over Ontario St., and down to a manhole where connection was made with undamaged underground feeders.

The trouble occurred at 2 a.m., Wednesday (Dec. 16), and partial service was restored to some sections by noon, but it was not until Friday night that full service was restored.

"Made in the U. S. A." Exposition

The "Made in the U. S. A." Industrial Exposition, to be held in the Grand Central Palace, New York, from Mar. 6 to 13, will be national in its scope and will embrace an extensive and comprehensive exhibition of important American manufactures in all lines of trade and industry. Its dates have been selected to show distinctly American products in New

York at a time when the city is the Mecca of buyers from all sections of the country in many different lines of trade, and special efforts are being made by leading export and other associations to bring South American and other foreign buyers to the city at this time.

This exposition is the outgrowth of the work of the committee organized by Joseph Hartigan, commissioner of weights and measures of the City of New York, and the organization of the exposition, which means so much to American trade, is in the hands of Harry A. Cochrane, one of the most successful organizers and managers of American trade shows and industrial expositions. The exposition is designed to answer a twofold purpose—to stimulate and increase the sales of American-made goods to our own and foreign buyers and also to educate the American public to the resources and productions of our manufacturers and show them the goods they can obtain in this country that they have heretofore purchased from abroad.

High-Tension Feeders Cause Subway Accident

The most disastrous accident in the history of the New York subway system occurred during the rush hour Wednesday morning, when twenty 11,000-volt feeders let go in two manholes adjacent to the tracks at Fifty-third Street.

Practically the entire system was tied up and several thousand people held in the trains. The smoke and fumes from the burning insulation pervaded the subway for considerable distance, resulting in the death of one person and rendering over two hundred people unconscious. Quick response was made by the hospitals and the fire department and all the available pulmotors were put into service. The firemen ripped off the sheet-iron pans and gratings, normally used for ventilation, and rescued many through these openings to the street.

A thorough investigation is under way by both the company and the Public Service Commission as to the initial cause of the disaster, and the report will be awaited with interest; for this is the second time within a month that feeders have failed with disastrous consequences, the other being in Cleveland as reported in our Dec. 29 issue.

OBITUARY

WALLACE W. MANNING

Wallace W. Manning, chief inspector for the New York branch of the Hartford Steam Boiler Inspection & Insurance Co., died of pneumonia, Sunday, Dec. 27, 1914, after an illness of about a week, at his home, 66 87th St., Brooklyn, N. Y., aged 34 years. He was born in Cincinnati, and had lived in Brooklyn for about 20 years, 16 of which were spent with the Hartford company. He was chief inspector for six years.

Mr. Manning was the son of Mr. and Mrs. John Howard Manning, who survive him, as does his widow, Margaret Manning, two children, Howard and Ward, and a sister.

Funeral services were held at 8 o'clock Wednesday night at his late residence, and the interment took place Dec. 31.

WILLIAM N. SMITH

William N. Smith died at his home, 380 Fifth St., Brooklyn, N. Y., on Jan. 3. Mr. Smith was born in Scotland 63 years ago and had made his home in Brooklyn for 43 years. He was the engineer at the Brooklyn Bridge power house for nearly 40 years, and was transferred only when that station was abandoned. He was well known in engineering association circles and had a host of friends. He was a past-vice-president of Brooklyn Association No. 8, N. A. S. E., past-president of the Modern Science Club, chairman of the Combined Associations of Engineers of Brooklyn for five years, a member of Melville Council No. 9, Universal Craftsmen, and the International Union of Steam and Operating Engineers. Mr. Smith was also past-master of Lexington Lodge No. 319, F. and A. M., and a member of the Masonic Veterans' Association, and Bridge Council No. 49, New York Civil Service Association. He leaves a widow, two sons and seven daughters. The funeral services were held at his late residence on Tuesday evening, Jan. 5, and were attended by delegations from the several organizations above mentioned. Interment was at Greenwood Cemetery on Wednesday at 2 p.m.

PERSONALS

Heinrich J. Freyn has resigned as third vice-president of H. Koppers Co., Chicago, effective December 1, 1914.

Paul H. Brangs has been elected a director of the Heine Safety Boiler Co. to fill the vacancy caused by the death of Colonel E. D. Meier. Mr. Brangs is manager of the New York office.

Prof. John J. Flather, head of the department of mechanical engineering of the College of Engineering of the University of Minnesota, is spending a year's leave of absence in Scotland.

Prof. W. H. Kavanaugh, head of the experimental department of the College of Engineering of the University of Minnesota, has been elected chairman of the Minnesota section of the American Society of Mechanical Engineers.

Arthur G. McKee announces that Robert E. Baker and Donald D. Herr, his business associates during a number of years past, have joined with him in the incorporation of his engineering and contracting business under the name of Arthur G. McKee & Co.

Maxwell Carson Maxwell, for the past seven years head of the Department of Applied Mechanics, Pratt Institute, Brooklyn, New York City, is now superintendent of power and plant of the Yale & Towne Manufacturing Co., Stamford, Conn. He is responsible for the power generation and distribution, building maintenance, new building construction, general repairs and maintenance of machinery, shafting, etc., and also has charge of the tool department.

ENGINEERING AFFAIRS

Washington University's Lectures on Public Utilities

The appointment of James E. Allison, some time chief engineer of the St. Louis Public Service Commission, as lecturer in economics in Washington University, is of particular interest to the students of engineering in the University. During the second semester of the current year, Mr. Allison will deliver a course of lectures, under the general direction of the department of economics, which will deal with the economic principles underlying the regulation of public utilities. Some of the specific problems to be studied are the organization and operation of public utility corporations, their securities and the methods of financing them, and especially the method of valuing public utility properties for taxation and rate regulation. Seniors in the School of Engineering will now be required to take this new course which will replace in part the second semester's work in general economics. It is believed that this course presents an unusual opportunity, both because of the importance of the subject and the high standing of the lecturer.

In order to further encourage the study of economics by students of engineering of Washington University, Mr. Allison has established a fund, to be known as "The Allison Fund," the annual income of which is to be used either for awarding cash prizes or in such manner as in the opinion of the dean of the School of Engineering and the head of the department of economics will best promote the object of the fund. When a prize is offered, competition will be open to the students of engineering who undertake a special investigation of the field of public utilities under the direction of the department of economics, with such restrictions as to eligibility as may be specified from time to time.

BOOKS RECEIVED

PRACTICAL LESSONS IN ELECTRICITY. By Robert A. Millikan, Francis B. Crocker and John Mills. American Technical Society, Chicago, Ill. Cloth; 318 pages, 5½x8½ in.; 323 illustrations.

ELECTRICAL MEASUREMENTS. By O. J. Bushnell and A. G. Turnbull. American Technical Society, Chicago, Ill. Cloth; 165 pages, 5½x8½ in.; 139 illustrations.

MATERIALS OF MACHINES. By Albert W. Smith. John Wiley & Sons, Inc., New York. Second edition. Cloth; 215 pages, 4¾x7½ in.; 36 illustrations.

MECHANISM OF STEAM ENGINES. By Walter H. James and Myron W. Dole. John Wiley & Sons, Inc., New York. 165 pages, 5¾x9¼ in.; 183 illustrations.